



# Status and Issues for Biodiesel in the United States

## *Alternative Fuel and Advanced Vehicle Technology Market Trends*

*National Renewable Energy Laboratory*

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## **Status and Issues for Biodiesel in the United States**

### ***Alternative Fuel and Advanced Vehicle Technology Market Trends***

#### **Current Market Status**

##### *State of the Technology*

Biodiesel is a renewable, biodegradable fuel that can be manufactured domestically from vegetable oils, animal fats, or recycled restaurant grease. In the United States, soybean oil is the largest feedstock for biodiesel production. Biodiesel is popular because it is domestically produced, supports U.S. industry, and represents a good balance of cost, emissions, cold-weather performance and materials compatibility. Low barriers to adoption and the scalability of biodiesel blend levels also contribute to its success as an alternative fleet fuel. The large number of diesel vehicles operating in the United States provides a significant opportunity to grow the biodiesel market.

Biodiesel can be blended with diesel and used in many different concentrations: The most common are B100, B20, B5 and B2. ASTM specification D975 allows for biodiesel concentrations of up to 5% to be called diesel fuel with no separate labeling required at the pump. Low-level biodiesel blends, such as B5, are ASTM approved for safe operation in any compression-ignition engine designed to operate on petroleum diesel. The fuel is distributed from the point of production to fuel distributors and wholesalers by truck, train or barge. Most biodiesel distributors will deliver B20 or B100 depending on a retailer's preference. B20 must meet quality standards specified by ASTM D7467. Engines operating on B20 have similar performance as engines using petroleum diesel. Clean Cities' focus is on blends of B20 and above. Further information in this report is for B20 and above blends unless otherwise noted.

Figures released in January 2015 by the U.S. Energy Information Administration (EIA) indicated 93 active biodiesel plants in the United States with a production capacity of 2.0 billion gallons per year.<sup>1</sup> U.S. Environmental Protection Agency (EPA) data also released in January 2015, shows U.S. biodiesel consumption during 2014 fell to 1.75 billion gallons, down from 1.8 billion gallons in 2013. Inconsistencies in the Renewable Fuel Standard (RFS) and the lapse of the biodiesel tax incentive at the start of 2014 likely account for the drop in production.

##### *Vehicles*

Every Original Equipment Manufacturer (OEM) of diesel vehicles approves the use of biodiesel blends up to B5. Nearly 80% of OEMs approve blends up to B20 in some or all of their diesel vehicles. The potential market for biodiesel can be determined by looking at the size of the country's diesel fleet. Data from R.L. Polk & Company indicate the total light-duty diesel fleet in the United States at 6.9 million vehicles, or 2.8% of the total U.S. fleet.<sup>2</sup> This includes Class 1, 2, and 3 passenger cars, light-duty trucks, SUVs, and medium-duty passenger vehicles with a gross

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<sup>1</sup> "Biodiesel Production Report." Energy Information Administration. Accessed February 13, 2015: <http://www.eia.gov/biofuels/biodiesel/production/>.

<sup>2</sup> R.L. Polk. Accessed January 23, 2015:

vehicle weight rating (GVWR) of < 14,000lbs. This number is nearly identical to the 6,858,151 medium- and heavy-duty diesel vehicles registered in the United States, meaning nearly 14 million existing vehicles are capable of using biodiesel.

The fueleconomy.gov website shows a growing number of diesel vehicle models available since 2012. In Model Year (MY) 2012, there were 17 light-duty models; this number had more than doubled by MY2015, with 37 models (Figure 1). The number of registered light-duty diesel vehicles also continues to grow. The growing number of all diesel vehicles on the road indicates that there is an expanding market and business case for public biodiesel stations (Figure 2).

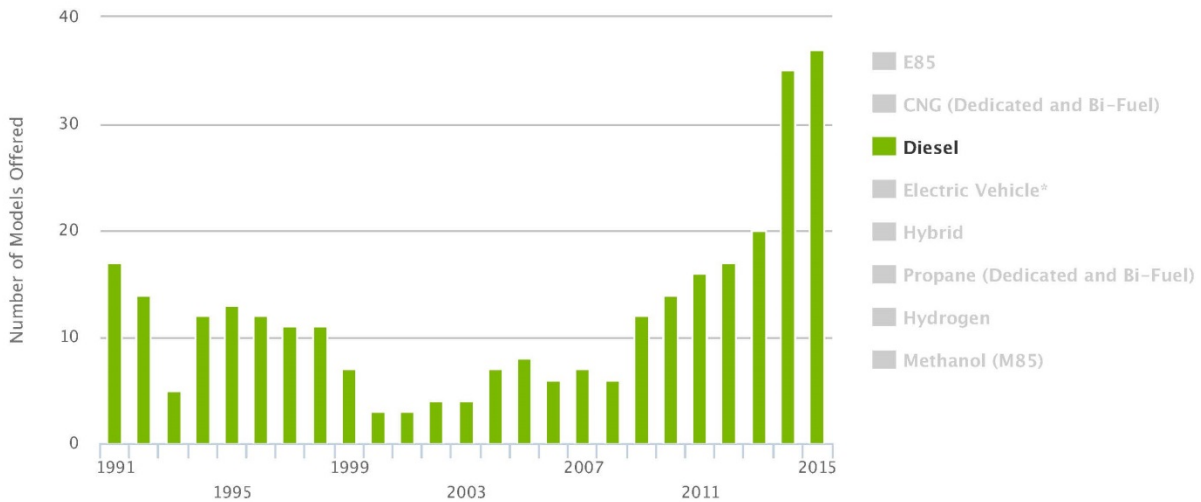
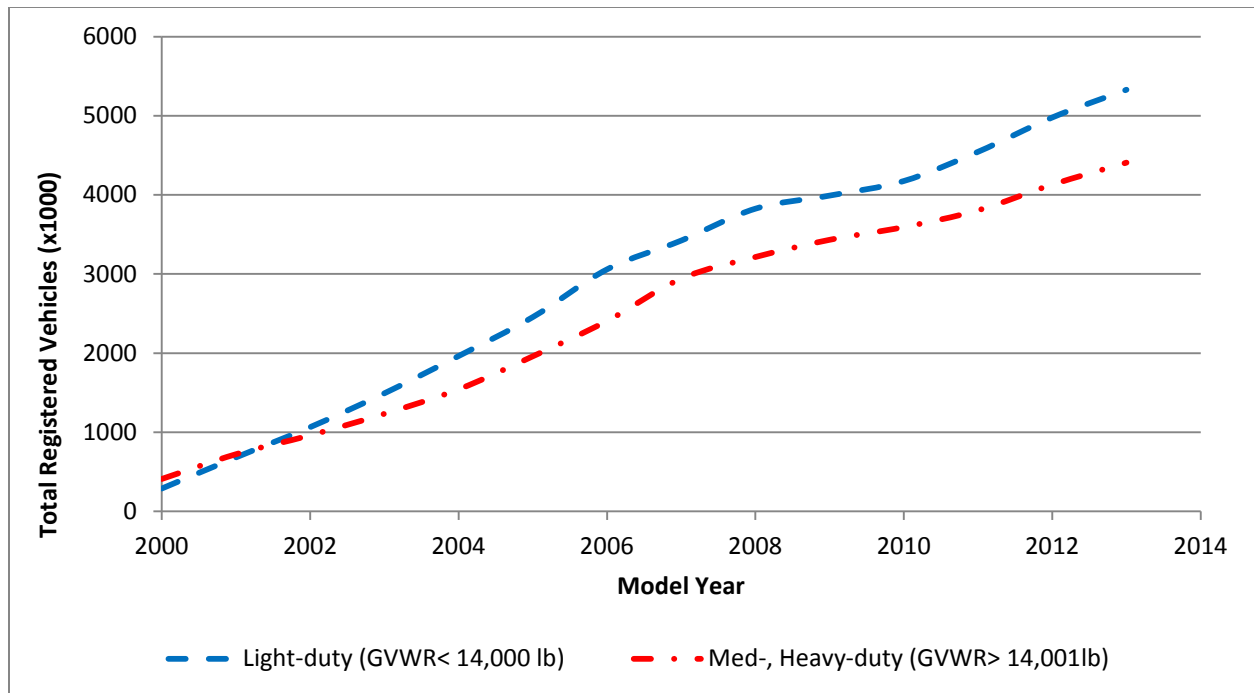


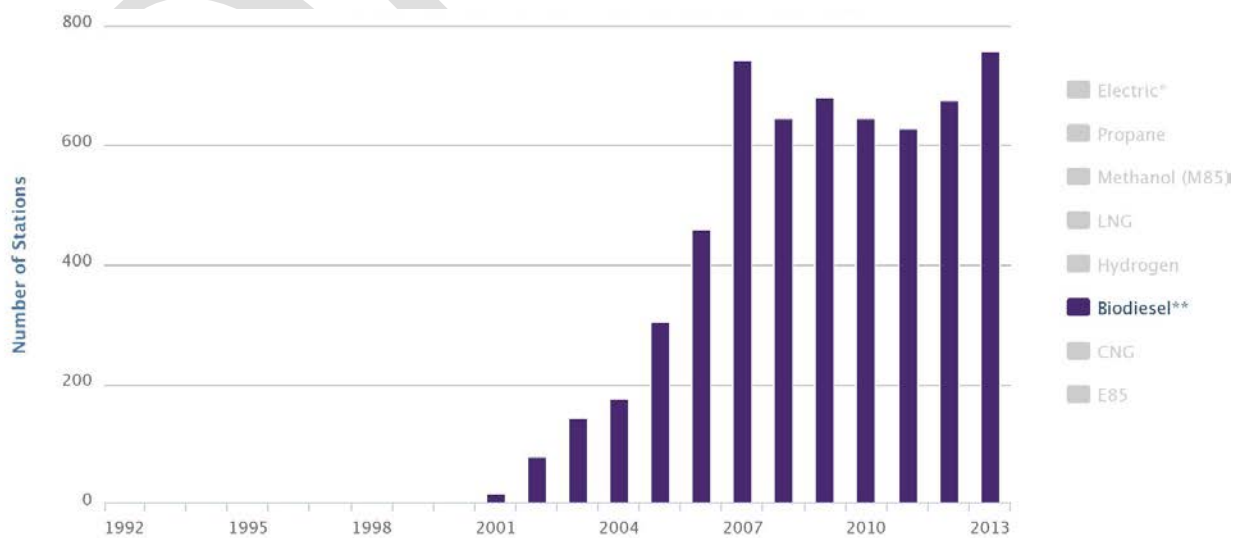
Figure 1. Number of light-duty diesel vehicle models (1991–2015)



**Figure 2. U.S. Diesel Vehicle Fleet Growth 2000–2013**

Infrastructure

Public and private industries are combining efforts to expand the retail presence of biodiesel, add a growing work truck segment and a growing number of light duty offerings, and the market for biodiesel in the United States is very robust. As Figure 3 shows, fueling infrastructure for B20 and above blends has grown substantially since 2001, with 2013 being a particularly strong year for the availability of B20 at fueling stations.



**Figure 3. Number of biodiesel fueling stations in the United States (1992–2013)**

Note that the dip shown in 2008 reflects a change in Alternative Fuels Data Center (AFDC) data collection methods. That year, the AFDC stopped collecting station locations when blends lower than B20 were being dispensed. Many fleets however use lower level blends year round.

### Laws and Incentives

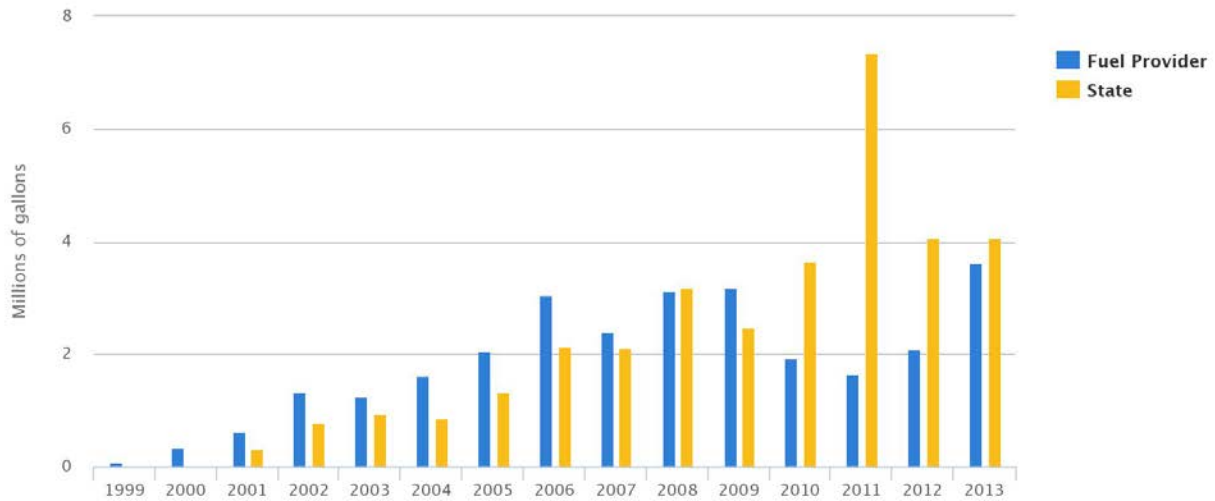
Federal and state laws, regulations, and incentives exist to increase the production and use of biodiesel while helping to ensure fuel quality, which is important given biodiesel's unique properties and diverse feedstocks. These measures apply to qualified producers, distributors, and users.

Federal biodiesel incentives have existed in many forms during recent years, but the majority have expired. The tax credit for small agri-biodiesel<sup>3</sup> producers was only available through 2011, and several other excise and income tax credits expired at the end of 2014, even after Public Law 113-295 retroactively extended them. The primary active biodiesel incentives come from the U.S. Department of Agriculture. For example, the Bioenergy Program for Advanced Biofuels provides biodiesel production payments to eligible advanced biofuel producers. The Biorefinery Assistance Program provides grants and loan guarantees for biofuel production. The Biomass Crop Assistance Program focuses on upstream biofuel crop production. All of these programs are funded through fiscal year 2018 but are subject to congressional appropriations thereafter.

Federal regulations have played an important role in the development of the biodiesel industry, including the U.S. Renewable Fuel Standard (RFS2) and vehicle acquisition and fuel use requirements for state and alternative fuel provider fleets. Smaller, but not less important, has been the sustained use of biodiesel by federally regulated fleets. Under the Energy Policy Act (EPAct) of 1992, qualified state government and alternative fuel provider fleets that operate, lease, or control 50 or more light-duty vehicles—with at least 20 used within a single metropolitan area—must purchase and use alternative fuel vehicles (AFVs). In 2007, the U.S. Department of Energy (DOE) issued an Alternative Compliance rule, which allows fleets to choose a petroleum reduction path as an alternative to using AFVs. The quantity of biodiesel consumption among EPAct-regulated fleets has increased steadily for state fleets. The large increase in 2011 is largely attributable to three states with unusually high reporting for biodiesel that year. Reporting among fuel provider fleets rose significantly in 2013 (Figure 4).

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<sup>3</sup> A small producer is one that has, at all times during the tax year, not more than 60 million gallons of productive capacity of any type of agri-biodiesel. Agri-biodiesel is defined as diesel fuel derived solely from virgin oils, including esters derived from corn, soybeans, sunflower seeds, cottonseeds, canola, crambe, rapeseeds, safflowers, flaxseeds, rice bran, mustard seeds, and camelina, and from animal fats; renewable diesel does not qualify for the credit.



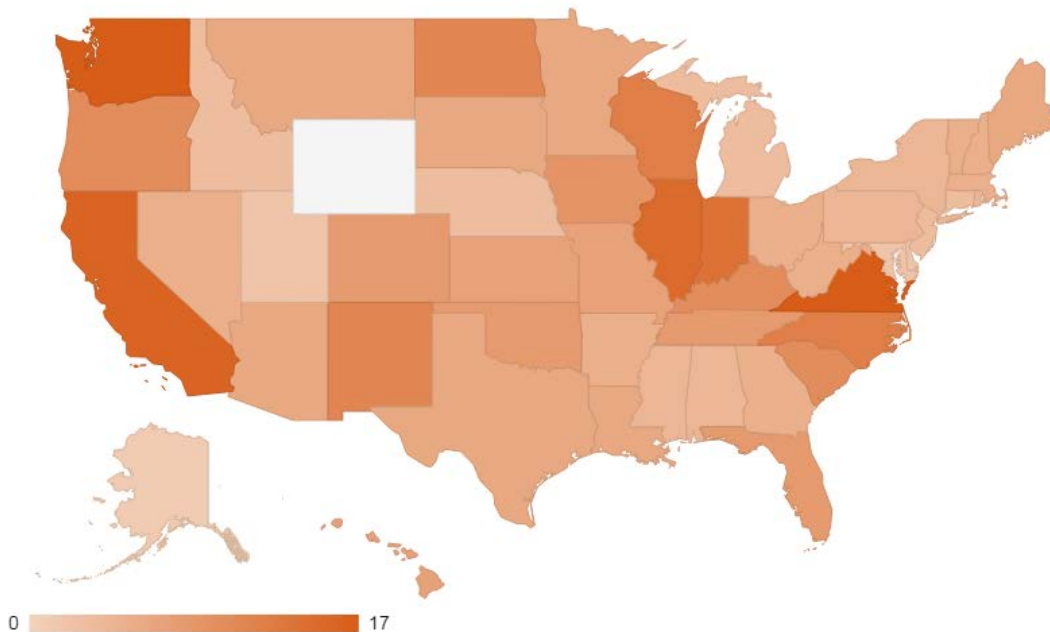
Source: National Renewable Energy Laboratory’s EPAct Task

Note: This chart shows the amount of biodiesel that fleets reported to DOE. Because fleets may earn only some of their needed acquisition credits by using biodiesel, they typically only report the portion for which they can earn credit.

**Figure 4. Quantity of biodiesel purchased by EPAct-regulated state and fuel provider fleets (1999–2013)<sup>4</sup>**

State incentives, laws, and regulations have also played a role in the sustained production and use of biodiesel across the country. As shown in the figure below, biodiesel incentives, laws, and regulations are concentrated along the West Coast, the Midwest, and the Mid-Atlantic states, corresponding to biodiesel production locations. Complementing the RFS2, California and other states have enacted low carbon fuel standards that require the use of fuels with low carbon intensity, thereby increasing the supply of biodiesel from certain feedstocks. Other states, such as Minnesota and Pennsylvania, have minimum biodiesel blending requirements for in-state diesel consumption.

<sup>4</sup> “Biodiesel Purchases by EPAct-Regulated Fleets.” Alternative Fuels Data Center. Accessed January 23, 2015: <http://www.afdc.energy.gov/data/10359>.



**Figure 5. Number of biodiesel incentives and laws, by state (2015)<sup>5</sup>**

Most states have defined fuel specifications to ensure quality, and the majority reference ASTM D6751. Because quality is an important consideration for biodiesel, a number of state agencies (e.g., agriculture departments) implement quality testing programs. Washington’s Motor Fuel Quality Program is one example.<sup>6</sup> At the national level, BQ-9000 is a voluntary accreditation program that combines ASTM D6751 with storage, blending, distribution, and fuel management standards.<sup>7</sup>

## **Industry Trends**

### Fuel Production

Biodiesel plant capacity exceeds demand, which means there is an opportunity to expand production if demand rises. Efforts to raise demand include a recent announcement by the biodiesel industry which will add a retailer initiative to the BQ-9000 fuel quality program and encourage retail stations to become accredited. The industry is also working to grow demand in the bioheat segment, and has supported research toward specifications that approve 6% to 20% biodiesel blended into traditional heating oil.

### Medium- and Heavy-Duty Vehicles

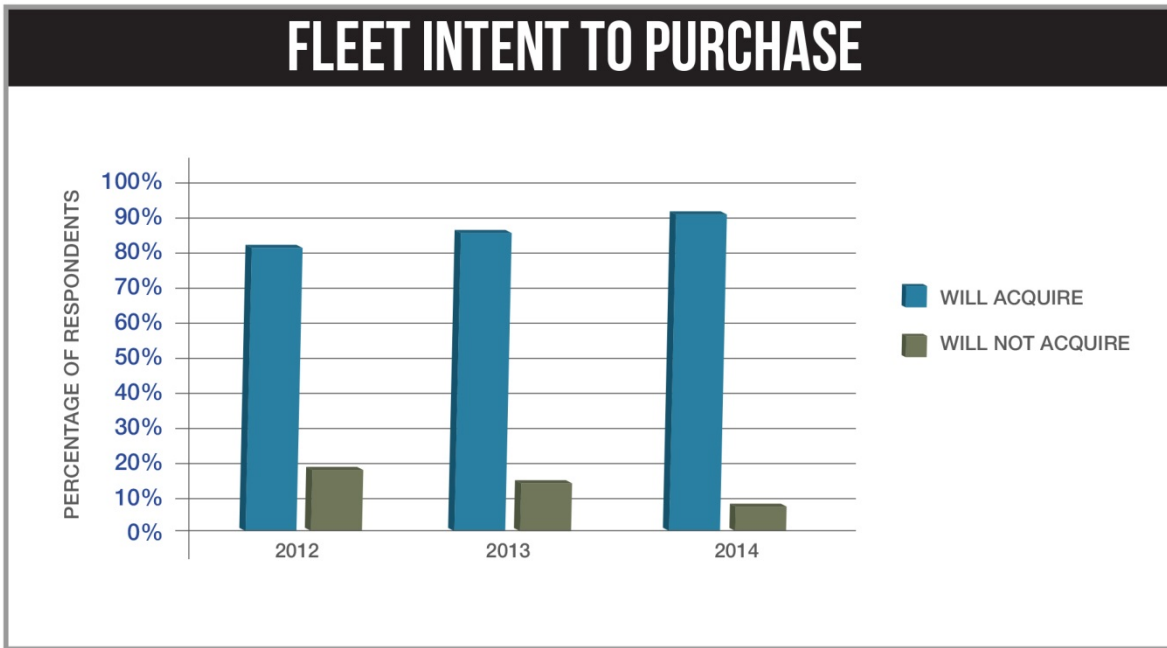
NTEA’s Fleet Purchasing Outlook captures fleet intentions for the work truck industry. The 2014 Outlook indicated that more than half of surveyed fleets plan to grow their fleet size in 2015 (Figure

<sup>5</sup> “Biodiesel Incentives and Laws, by State.” Alternative Fuels Data Center. Accessed January 23, 2015: <http://www.afdc.energy.gov/data/10372>.

<sup>6</sup> “Motor Fuel Quality Program.” State of Washington. Accessed January 23, 2015: <http://agr.wa.gov/bioenergy/standards.aspx>.

<sup>7</sup> “National Biodiesel Accreditation Program.” Accessed January 23, 2015: <http://www.bq-9000.org/>.

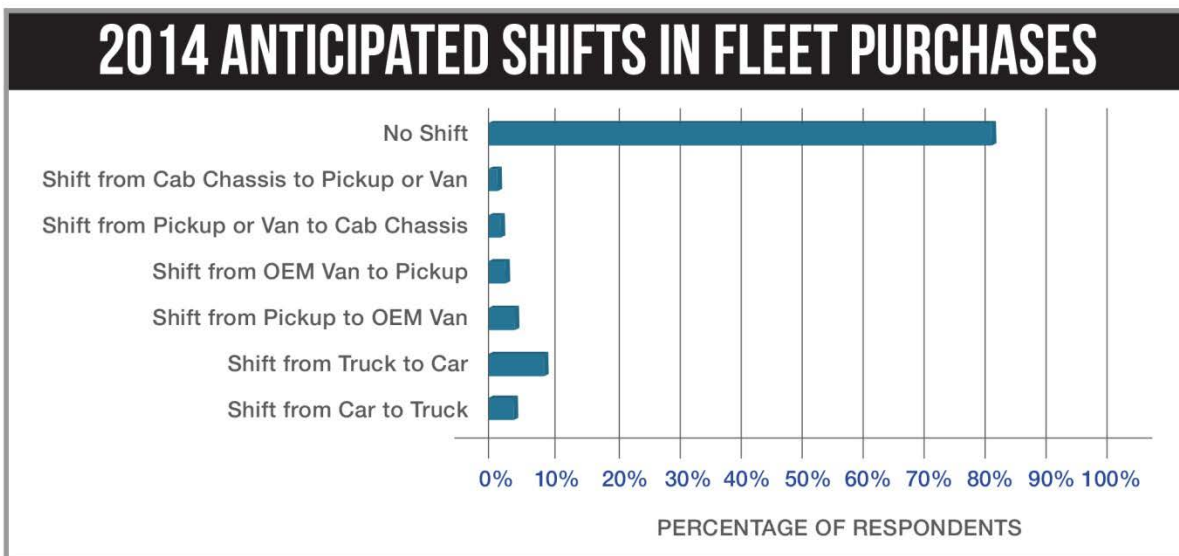
6). Nearly 90% of fleets said they intend to purchase trucks. In addition, more than 50% of survey respondents said they use alternative fuels. This indicates a growing trend in the industry of turning to alternative fuels to save money and protect the environment but as shown in Figure 7 the overall composition of the market will remain about the same. Overall, the upward trend in purchasing, fleet size, and alternative fuel use combined with a push for a more retail presence, has set the stage for a stronger biodiesel market.



SOURCE: NTEA 2012, 2013 and 2014 Fleet Purchasing Outlook Surveys

FIGURE 12

Figure 6. Anticipated truck acquisitions by fleets in 2014 versus 2013



SOURCE: NTEA 2014 Fleet Purchasing Outlook Survey

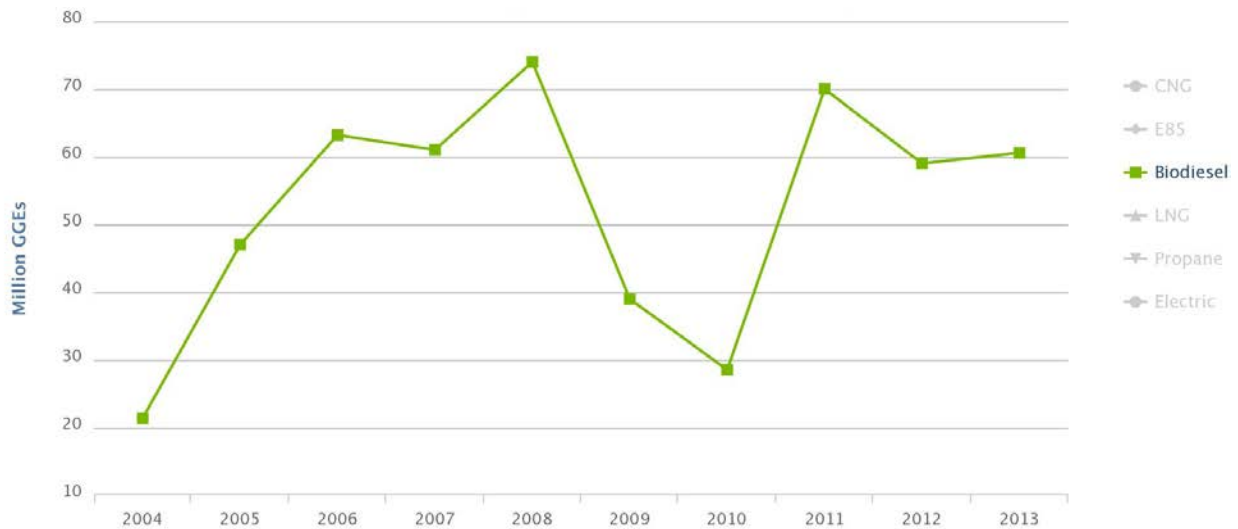
FIGURE 16

Figure 7. Anticipated shift in types of vehicles purchased by fleets in 2014



## Clean Cities Activities

Clean Cities coalitions reported 60.57 GGEs of biodiesel in 2013. The dip in 2009 and 2010 can be attributed to a reporting change. Prior to 2009, coalitions could report a low level blend used within their coalitions, but reporting was switched in 2009 to include only projects using B20 or higher blends. So the actual use of B20+ blends has increased significantly since 2009 (Figure 8).



**Figure 8. Quantity of petroleum displaced by Clean Cities' biodiesel use (2004–2013)**

Below is a list of current Clean Cities tools and publications support a biodiesel strategy.

### Tools

- Alternative Fuel and Advance Vehicle Search: Vehicles Capable of Using Biodiesel
- AFLEET
- Petroleum Reduction Planning Tool
- Station Locator Enhancements: Seasonal Biodiesel Blends
- Biodiesel Cost Calculator
- TransAtlas
- BioFuels Atlas
- WATER Footprint (Office of Biomass Energy funded.)

### Publications

- Fleet Experience Success Stories on the AFDC web site
- MotorWeek Success stories on Clean Cities YouTube channel
- Biodiesel Basics fact sheet
- Biodiesel Handling and Use Guide, 4<sup>th</sup> Edition
- Straight Vegetable Oil as a Diesel Fuel?

Additionally, the National Clean Fleet Partnership and National Parks Initiative include biodiesel as part of their overall approach.

### **Emissions Benefits**

Engines manufactured in 2010 and later have to meet the same emissions standards, whether running on biodiesel, diesel, or any alternative fuel. Selective catalytic reduction (SCR) technology, which reduces nitrogen oxides (NO<sub>x</sub>) emissions to near zero levels, makes this possible. These engines are some of the cleanest engines on the road, and the emissions from diesel fuel are comparable to those from biodiesel and are very low.

Using biodiesel reduces greenhouse gas emissions because carbon dioxide released from biodiesel combustion is offset by the carbon dioxide absorbed while growing the soybeans or other feedstock. B100 use reduces carbon dioxide emissions by more than 75% compared with petroleum diesel. Using B20 reduces carbon dioxide emissions by 15%.

Greenhouse gas and air-quality benefits of biodiesel are roughly commensurate with the blend: that is, B20 would have 20% of the GHG reduction benefit of B100. B100 use could increase nitrogen oxides emissions, although it greatly reduces other emissions.

### **Fuel Research**

Significant research is ongoing in the biodiesel industry. Projects are addressing fuel stability for long-term storage, stability to address issues with B20 warranties for a small number of OEMs, and new feedstocks.

### **Niche Market Opportunities**

Because biodiesel blends below B20 can be used in place of diesel fuel with no modification in most vehicles, the opportunity for introduction into fleets is vast. As increasing volumes of biodiesel are produced in the United States, low-level blends, such as B2 and B5, are becoming more common throughout the country. Higher blends, like B20, are also becoming more common. Some potential for complementary technologies exists, such as hybrid vehicles running on B20 instead of regular diesel.

The opportunity for niche market adoption of biodiesel is broad because initial investment is low and presents few barriers. The use of biodiesel blends in areas that are already targeted for emissions reductions is an easy first step. Potential target niche fleets may be diesel vehicles operating at ports and local delivery trucks that return to a central garage each night.

- **Ports:** Many ports already have restrictions on trucks at the ports, requiring 2007 and newer technology (and retrofits) before access to the ports. By coupling these clean diesel modifications with biodiesel blends, additional emissions reductions are possible. Many local truck fleets may already be pursuing petroleum reduction strategies, such as hybridization. The

benefit of biodiesel is that it can be “stacked on” hybrids, further increasing the greenhouse gas emission reductions and displacing even more petroleum.

- **School Buses:** School bus fleets are interested in biodiesel as a way to reduce emissions. A best practice for school bus fleets is to identify low emitting or low GHG solutions. Biodiesel offers them a lower initial investment than other alternative fuel choices, since vehicles and infrastructure do not need to be modified to accommodate biodiesel blends of B20 or lower.
- **Work Trucks:** The work truck industry demonstrates the growing interest in alternative fuels in general. Biodiesel provides these fleets with relatively low cost to initiate a project. This segment is particularly sensitive to fuel cost, so their adoption of biodiesel will greatly depend on the price differential between biodiesel and conventional diesel.

### **Barriers and Challenges**

Biodiesel is a mature technology with few challenges to adoption. The major challenges facing industry are: continued focus on quality, growing demand, identifying new feedstocks, and investigating issues related to B20 warranties. Adopters of biodiesel may need to consider factors such as: what blend level meets their needs, whether tracking biodiesel use is needed and how this informs blend levels, how and where vehicles will be fueled, and whether existing tanks can be repurposed.

### **Strategies for Advancing the Use of Biodiesel**

Several national Clean Cities activities could be updated or enhanced to advance the use of biodiesel. These include:

- **Actively engage school bus and work truck industry:** Clean Cities is already highly engaged with these two markets. Collaborating with the biodiesel industry in conjunction with the industry groups for school buses and work trucks will ensure we understand the challenges of each group. Activities would include securing speaking roles at conferences, writing articles for industry publications and collaborating with industry groups to hold webinars for their members. Webinars especially will ensure we understand barriers and concerns for each niche.
- **Ports:** Historically only a small number of coalitions have been engaged with ports. As a first step Clean Cities can convene those coalitions to understand their successes and challenges and share expertise. Developing a suite of materials focused on ports will enable coordinators to be effective. Materials may include existing biodiesel fact sheet and handling and use guidelines, how the tools on the AFDC web site could be used to understand emission reductions, and producing case studies of successful biodiesel use at ports. Identifying port specific industry groups and conferences to partner with is also important. Currently Clean Cities has not worked with any groups that are port specific so it is ground up effort to identify the groups and most relevant conferences and document a strategy to begin building a partnership.

- **Retail BQ9000:** Work with the National Biodiesel Board (NBB) to educate coordinators about the BQ900 program for retailers and define actions coordinators can take with retailers locally.
- **Success stories and Toolkits:** Understand the most relevant success stories among fleets using biodiesel, and communicate success stories at the national level and make them available to coordinators. This will satisfy the continued desire among fleet managers to understand how others have been successful in doing what they want to do. Documenting relevant success stories also presents an opportunity to identify niche markets that have adopted biodiesel and therefore new niches that Clean Cities could develop industry partnerships with. A case study on success in the bakery delivery niche is one such industry.
- **Biodiesel Handling and Use Guidelines:** Update this highly-used publication, and partner with industry groups like the National Truck Equipment Association (NTEA) and the National Association of Convenience Stores (NACS) to get it to their members.
- **Coordinator education and training:** Determine what information or knowledge gaps exist, and work to fill those using a variety of methods, including fact sheets, success stories, case studies, Clean Cities University, webinars, and in-person trainings.

On the local level coalitions could:

- **Understand availability:** Coalitions must understand local availability of biodiesel in order to successfully educate fleets. Coordinators who do not already understand local supply and know the delivery companies should work to educate themselves on the local market.
- **Identify barriers:** Coalitions can proactively identify the challenges that fleets may have for biodiesel adoption. Coalitions can then communicate those challenges back to the national program to ensure that the challenges are being addressed.