

Biomass-Based Diesel and Heating Fuel Substitute Opportunities in New York City



Final Report
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1 Executive Summary

As part of Mayor Bloomberg's ongoing efforts to combat climate change, New York City (NYC) has undertaken significant efforts to reduce greenhouse gas emissions through strategic initiatives. Among those initiatives are efforts to encourage the use of clean transportation fuels among city-owned fleets and requirements for cleaner burning heating fuel. Biomass-based diesel fuels are ideally-suited to help NYC and New York State meet emission reduction targets set by:

- 80x50: This New York State target established by Executive Order No. 24 intends to reduce greenhouse gas (GHG) emissions by 80 percent by 2050 from 1990 emission base levels;
- 30x30: Through PlanNYC, the City established a GHG emission reduction target of 30 percent by 2030 from 2005 emission base levels through a variety of options, including sustainable transportation and efficient buildings;
- 30x17: As a subset of the PlanNYC goal, the City established a municipal GHG emission reduction target of 30 percent by 2017 from 2006 emission base levels from municipal operations, including fleets and improvements to the City's existing buildings; and
- Bioheat blend requirement: As a result of local law 2010/043, NYC requires all commercial and residential heating oil used in the city to have a two percent biodiesel composition beginning in 2012.

The objective of this report is to assess the current infrastructure for biomass-based diesel fuels in NYC. The report is organized with the assessment of the core issues related to biomass-based diesel fuel use, including a review of the current supply and demand (in NYC and in the U.S., as appropriate), refueling infrastructure, and the compatibility with today's vehicle fleet. The report then considers the main drivers and issues, categorized as regulatory, technical, and economic, to assess the current landscape for diesel substitutes. The report then reviews forecasts of production and consumption of biomass-based diesels, with a focus on NYC, based on policy and regulatory constraints. Finally, the report identifies barriers that must be overcome to achieve the higher biomass-based diesel consumption in NYC and recommendations to overcome those barriers.

NYC currently has a significant liquid fuels market for both transportation and buildings and also serves as the center of the Northeast petroleum supply chain with many local terminals. The progressive policies and targets discussed above will increase the quantity of alternative fuels, such as biodiesel, consumed in these liquid fuels markets. NYC generates a significant amount of local feedstocks that could be used to produce biomass-based diesels, such as yellow and brown grease, which have spurred the development of two locally-based biodiesel facilities, United Metro Energy Corp. and Tri-State Biodiesel, LLC. With NYC's focus on energy innovation and market opportunities, biomass-based diesel production could provide additional local economic development and job creation opportunities.

However, implementing a biodiesel growth strategy involves identifying and resolving barriers in the market that inhibit growth in biodiesel sales. This includes the development of the market in areas of supply assurance, storage and delivery infrastructure, quality assurance, end user equipment compatibility, price competitiveness and clear policies for all stakeholders. NYC has provided leadership

in a number of these areas. ICF International's (ICF) key findings are noted below, followed by recommendations for further consideration toward meeting the City's 80 by 50 goals:

1.1 Key Findings

1. NYC requires all commercial and residential heating oil used in the city to have a two percent biodiesel (B2) composition as of October 2012. The Department of Parks and Recreation uses B20 in all of its diesel vehicles and equipment, and other agencies, including the departments of Sanitation, Transportation, and Environmental Protection, use B5 in their diesel fleets and switch to B20 between April and November. Port Authority vehicles at JFK Airport rely on B20 year-round for diesel equipment ranging from airport shuttles and buses to plows clearing snow.
2. In 2011, NYC consumed approximately 150 million gallons of on-road diesel and 900 million gallons of heating oil, including No. 2, No. 4, and No. 6. Prior to the implementation of the B2 bioheat requirement, only 60,000 gallons of biodiesel were used in fuel oil in 2011. ICF forecasts that in 2013 approximately 20 million gallons of biodiesel will be consumed due to the heating oil B2 requirement.
3. Biodiesel has been competitively priced with ULSD since January 2011 when the biodiesel mixture excise tax credit (also known as the biodiesel blenders credit) was reinstated providing a tax credit of \$1.00 per gallon of pure biodiesel. The value of RINs, which spiked in July 2013, fell well below \$0.50 by the end of 2013.
4. Input from stakeholder interviews indicate that supply of biodiesel should not be a concern for NYC's growth strategy. This is because:
 - a. A large portion of NYC supply is transported from the Midwest or Southern markets;
 - b. Biodiesel plants in the region supplying NYC are estimated at current utilization of 30 percent, of a 247 million gallon annual capacity, and therefore have unused capacity of 172 million gallons per year (MGPY). Thus for an on-road and/or heating oil B5 mandate there is sufficient existing capacity in the region to supply biodiesel;
 - c. The U.S. continues to be a net exporter for biodiesel; these volumes could instead be potentially available for consumption in the U.S. if demand picks up; and
 - d. The acquisition of the former Metro Biodiesel plant in Brooklyn by United Metro Energy Corp. should provide an additional and substantive local supply source when planned completion occurs in 2013.
5. There are 150 sites with over 3.1 million gallons of tankage dedicated to biodiesel in the five NYC boroughs alone. In addition, DEC Region 1 (Long Island) has close to 5 million additional gallons of capacity. Based on interviews with key industry leaders, if additional biodiesel mandates are implemented, terminals can easily add or convert more tankage capacity as needed.

6. Biodiesel is compatible with both existing underground storage tanks and terminal tankage and thus does not pose a barrier to increased biodiesel consumption.
7. In some instances equipment limitations for both on-road and off-road applications will prevent the adoption of higher blends of biodiesel and other biomass-based diesels. Additionally, there are existing regulatory limitations, such as permitting, inspection, and limited equipment options, which are preventing the widespread conversion or installation of dispensing equipment for biodiesel. Trade organizations, such as the National Biodiesel Board (NBB), are working with key stakeholders, including vehicle and heating oil burner manufacturers, federal, state, and local regulatory agencies, supply chain companies, and end-users to eliminate these barriers. For example, NBB has been working closely with the City to coordinate with heating oil burner manufacturers to certify equipment for up to B20. Additionally, Parks and Recreation has been working closely with NBB and underground storage tank manufacturers to certify all City-owned equipment for up to B100.

1.2 Key Recommendations

1.2.1 Regulatory Changes & Requirements

- **Require all retail stations to properly label diesel pumps to disclose biomass-based diesel content**

To encourage transparency and educate citizens, all retail stations in NYC selling ULSD with biomass-based diesel content should be required to disclose such information on pump infrastructure for any blend above B2. A labeling program comparable to ethanol content disclosures (e.g. E10) would be a good model to use.
- **Require biomass-based diesel content be included on the bill of lading**

All NYC fuel suppliers should be required to include any applicable biomass-based diesel content on the bill of lading. The City should enforce this requirement through standard protocols. The requirement will help retailers comply with biomass-based diesel label disclosure on refueling infrastructure.
- **Develop standard inspection protocols in conjunction with the New York Fire Department**

The NY Fire Department (NYFD) should be consulted on the development of a broader protocol for permitting biodiesel blends in USTs, particularly a program that would mirror EPA requirements. Protocols in consideration should include a variance policy for biodiesel blends above B20. The protocol may include a more streamlined process for public retail stations. To date, NYFD does not have any written regulations and cannot issue any regulations that would waive or reduce EPA regulations, but can implement more stringent requirements. The City and NYFD should develop a city-wide waiver for biodiesel in city-owned USTs for blends less than B20 and variance requirements for blends above B20.

1.2.2 Consumption Targets and Mandates

- Increase bioheat requirements from B2 to B5, and expand the definition to include other biomass-based diesels**

The City should increase the bioheat requirement beginning by July 1, 2015 from B2 to B5 and expand the definition of eligible biomass-based diesel fuels to include renewable and cellulosic diesels that comply with ASTM fuel specifications. The City should also have the goal of reaching a B20 blend once the ASTM standard for B20 bioheat has been released. Based on information provided by the National Biodiesel Board (NBB), the B20 bioheat standard may be available anytime between 2015 and 2019. In the interim, NBB is advising consumers to use the ASTM D7467 standard for on-road blends of B6 to B20 for the purposes of bioheat. Generally, on-road fuel specifications are more stringent than those in heating oil.¹

As a first step, NYC should coordinate with local bioheat stakeholders to ensure that adequate time is available to integrate infrastructure with the blending requirement and that the appropriate assistance is provided to stakeholders, such as dealers. The City should also include claw-back provisions to account for potential spikes in price or reductions in supply.

- Expanded Use of Biomass-Based Diesels in the Transportation Sector**

The City should consider imposing a local requirement for B5 or 5 percent renewable diesel (R5) blending among all publicly-accessible on-road diesel refueling stations to increase the local demand and consumption of biodiesel. As all vehicles are warrantied up to B5 and R5 all diesel vehicles will be able to use the fuel.

As a first step, the City of New York should coordinate with local retail stations, marketers, terminals, and other key stakeholders to ensure that adequate time is available to integrate infrastructure with the blending requirement and that the appropriate assistance is provided to stakeholders to comply with the requirement. The requirement should also be discussed with State officials to insure that the City has the authority to implement the requirement, and to consider the benefits of a statewide requirement. The City should also include claw-back provisions to account for potential spikes in price or reductions in supply.

- Increase the use of Biomass-Based Diesels among City fleets and encourage use in other large fleets**

In FY2012, City agencies, including Parks and Recreation and Sanitation, consumed over 9 million gallons of biodiesel. In order to reduce pollution and expand consumption, B5 should be used in every City-owned diesel fleet vehicle, including emergency vehicles, with the long-term goal of increasing the percentage of biodiesel consumption and expanding the use to include other biomass-based diesel fuels, such as expanding to B10 or B20 blends among all City fleets. For non-City owned fleets, such as the MTA, the City should encourage the adoption of biomass-based diesels and coordinate where possible with large private fleets.

¹ Based on email communication with Steve Howell, National Biodiesel Board, April 11, 2013.

For example, in 2005, the New York Power Authority (NYPA) partnered with the New York City Department of Education to reduce harmful emission in NYC city school buses through the installation of emission reduction devices and the introduction of ULSD. Emissions reduction devices were installed on school buses owned by independent fleet operators participating in the program. Since this effort, no further work has been done to improve the efficiency of NYC school buses. As the National Clean Diesel Campaign provides funding for projects that make the switch to cleaner fuels, NYC might use this opportunity to apply for funding to switch all city school buses to biomass-based diesel fuel, in particular, biodiesel.

1.2.3 Fuel Quality Requirements

- Encourage the use of product from BQ-9000® producers and marketers**
 Though it should only be a voluntary standard, the City should encourage biodiesel suppliers to source and use product from BQ-9000® producers and marketers in order to ensure quality control. BQ-9000® producers and marketers are audited every year to ensure that the fuel is consistently meets ASTM D6751 requirements.

1.2.4 Feedstock Development Programs

- Develop a residential grease collection program**
 The City should work with the Sanitation Department to create a recycling program for residential greases and vegetable oils. Each year, the City spends millions of dollars in repairs to sewer lines created by improper disposal or illegal dumping of fats, oils, and greases (FOGs). A proper residential grease collection program could not only save money in costly repairs, but also be used to generate biomass-based diesels.
- Create exploratory committee to evaluate the use of FOGs from wastewater treatment facility for biomass-based diesel fuels**
 The City should appoint a task force to explore potential opportunities to use FOGs collected at municipal wastewater treatments plants (WWTPs) to be used in biomass-based diesel production. This opportunity could potentially save the City millions of dollars annually in tipping fees and create a new revenue stream. Given the high concentrations of contaminants in most FOGs collected at WWTPs, including water, fecal materials, and other residuals, the task force should oversee the collection and analysis of feedstock samples and survey existing efforts to produce biodiesel from this feedstock source to determine if it is a viable opportunity. The task force may also consider other opportunities for the feedstock, such as biogas production.

1.2.5 Reporting

- Incorporate biomass-based diesels into carbon-emission reduction goals**
 As part of its efforts to achieve carbon emission reductions, biomass-based diesel consumption should be one method to meet the goal of reducing distillate-based emissions. Accounting for these initiatives through reporting management will help the City to account for any emissions reductions. Comparable to the annual reporting requirement for the B2 mandate among all

relevant retailers of bioheat, any policy or program initiated by the City should also incorporate some type of reporting requirement as well.

- **More standardized reporting for biomass-based diesel consumption among agencies**
 City agencies should streamline reporting to the Department of Citywide Administrative Services to ensure proper accounting for biomass-based diesel consumption. Reporting should include consumption quantities, blend ratio, price, application (e.g., bioheat, on-road) and any reported incidents with the fuels.

1.2.6 Training and Outreach

- **Educate City staff through existing fuel training programs**
 All City staff should be trained to use and handle biomass-based diesels as part of standard fuel training and use protocols. City staff responsible for equipment exposed to biodiesel should be aware of maintenance modifications and other precautionary requirements for biodiesel content. City staff responsible for maintaining, installing, and repairing underground storage tanks (USTs) containing biodiesel should be aware of maintenance modifications, biodiesel preparation, and any other necessary equipment repairs or modifications.
- **Outreach to equipment manufacturers and supply-chain companies in support of biomass-based diesel fuels**
 The City should prepare the market for a proposed roll-out of additional biomass-based requirements through strategic outreach to equipment manufacturers and suppliers. Outreach could include engagement with fuel suppliers and distributors, associations, end-users, contractors, and other stakeholders to integrate their concerns and needs into any subsequent requirements.

1.2.7 Next Steps

1.2.7.1 Economic Development Study

As part the policy review process the City should evaluate opportunities for economic development as a direct result of the expansion of the B2 bioheat requirement to B5 and B20 and the potential mandate to require B5 in on-road diesel vehicles. The report could evaluate the ability to utilize locally produced feedstocks in and around the NYC area, such as yellow grease and brown grease, and direct and indirect investment, local revenue, and job creation opportunities.

2 Introduction to Biomass-Based Diesels

2.1 What are Biomass-Based Diesels?

As part of Mayor Bloomberg’s ongoing efforts to combat climate change, New York City (NYC) has undertaken significant efforts to reduce greenhouse gas emissions through strategic initiatives. Among those initiatives are efforts to encourage the use of clean transportation fuels among city-owned fleets and requirements for cleaner burning heating fuel. Biomass-based diesel fuels are ideally-suited to help NYC and New York State meet emission reduction targets set by:

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2.1.1 Introduction: Biomass-Based Diesels

Biomass-based fuels are a general term used to describe mixtures of diesel fuels with a range of concentrations (between 2 and 99.9 percent) of biomass-based distillate.² Biomass-based distillate fuel, also known as biomass-based diesel, substitutes are comprised of liquids having the compression ignition characteristics of diesel fuel, but are derived from non-petroleum (i.e., biomass-based) feedstocks. The diesel substitutes discussed in this report include biodiesel, renewable diesel, and cellulosic diesel.

Biomass-based diesel is currently produced in the U.S. and elsewhere from vegetable oil, animal fat, or waste oils. Despite the wide variety of biomass-based diesel options described below, the dominant biomass-based diesel fuel currently available to NYC is biodiesel. Pure biodiesel (e.g., B100) is available in the marketplace and can be used in some engines without modification, though biodiesel blends of up to B20 are the most common blends sold in retail markets. Blends of up to B5 can be used in most vehicle diesel engines without modification. Biodiesel is generally more cost-competitive with other biomass-based diesel fuels, relatively inexpensive to produce, and well-established in the market. However, in the next few years, ICF anticipates that other biomass-based diesel fuels, such as renewable diesel, will be commercially available in the NYC area and stakeholders should consider the use of these fuels in future policy and regulatory discussions. A brief definition of each of these biomass-based diesels is below.

Oftentimes, stakeholders associate biomass-based diesels with ethanol. However, there are a number of differences between the two fuels even though both are derived from renewable feedstocks. The primary difference is related to the type of fuels that they each displace. Biomass-based diesels can only be used as a substitute for diesel fuels and heating oils, while ethanol can only be used as a substitute for gasoline. Some organizations advocate that biomass-based diesels are preferable to ethanol due to attributes such as: easier integration with existing fuel supply infrastructure; scalable production process; diversified feedstock supply chain, and; better environmental attributes.³ Though ethanol will not be discussed in detail in this report, it is worth noting that despite the potential positive or negative attributes of each biofuel, they each have a role in reducing conventional fossil fuels.

2.1.1.1 Biodiesel

Biodiesel is a fatty acid methyl ester (FAME) that can be synthesized from vegetable oils, waste oils, fats, and grease, which contain fat molecules (also known as triglycerides) into fatty acid esters. The chemical reaction (also known as transesterification) requires the addition of an alcohol (typically methanol) to supply the needed oxygen.

Typically, biodiesel can be used in smaller blends with petroleum based distillates without creating any problems in existing diesel engines, dispensing equipment and storage tanks. However, biodiesel is not currently compatible with pipeline infrastructure due to jet fuel contamination issues⁴ and can create

² Distillate fuel oil is a general classification for one of the petroleum fractions produced in conventional distillation operations. It includes diesel fuels and fuel oils. Products known as No. 1, No. 2, and No. 4 diesel fuel are used in on-highway diesel engines, such as those in trucks and automobiles, as well as off-highway engines, such as those in railroad locomotives and agricultural machinery. Products known as No. 1, No. 2, and No. 4 fuel oils are used primarily for space heating and electric power generation.

³ For example: Alternative Fuels Americas, "Biodiesel vs. Ethanol," accessed June 26, 2013, http://www.alternativefuelsamericas.com/index.php?option=com_content&view=article&id=6&Itemid=8.

⁴ Pipeline standards are currently being developed.

problems in existing equipment at higher blends due to the fuels' solvent property, which cleans and dislodges debris and other materials from fuel lines, vehicle fuel tanks, and dispensing tanks, resulting in clogged fuel filters or lines and disruption to vehicle operations. This is more pronounced in older vehicles where debris and build-up on fuel lines could be substantial.⁵ Often equipment needs to be modified and prepared in order to use higher blends of biodiesel, therefore most mandates only include requirements for B5 or less, which are recognized by ASTM International (an internationally-recognized certification entity) as having the same chemical properties as petroleum-based diesels.

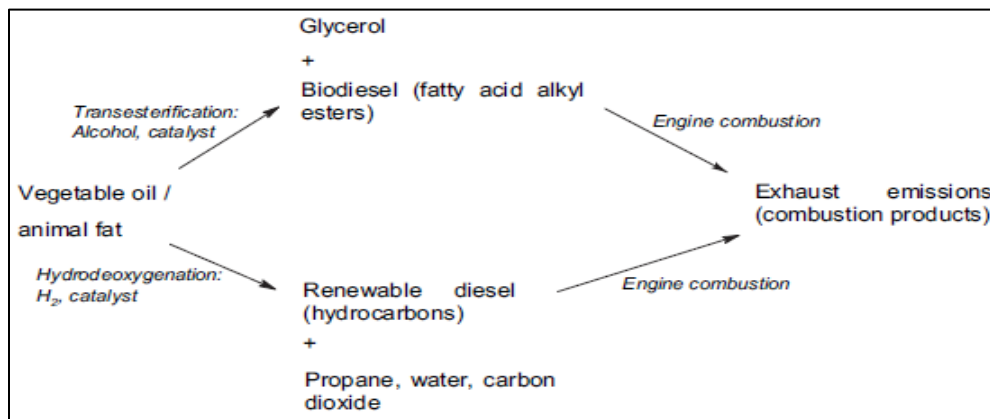
2.1.1.2 Renewable Diesel

Renewable diesel is produced from fats through chemical reaction using high pressure and hydrogen that forces fat molecules found in vegetable oils, waste oils, fats and greases to break apart into hydrocarbons (also known as hydro-processing – comparable to the process used to refine crude oil into gasoline and diesel). Because the products of this process are hydrocarbons, not esters, they are often termed non ester renewable diesel (NERD).

Renewable diesel meets the same American Society for Testing (ASTM) standards (ASTM D975 (petroleum diesel) or ASTM D396 (home heating oil)) as conventional diesel and therefore the product is interchangeable with conventional diesel and does not have any blending limitations – it can be transported via pipeline, stored in the same facilities as diesel, and used without volume constraints in vehicle applications. Several facilities in the U.S. are producing renewable diesel, including Dynamic Fuels in Louisiana, which has a partnership with Tyson Foods to convert animal fats from a local rendering facility into renewable diesel.

Exhibit 1 shows a process flow chart of biodiesel production, compared to renewable diesel, showing the different reactions and byproducts.

Exhibit 1: Biodiesel and Renewable Diesel Production Process Flow Chart



Source: U.S. Department of Agriculture, 2009.⁶

⁵ Keith Kerman, City of New York Parks & Recreation, "Report on the Use of Biodiesel and Ultra Low Sulfur Diesel for Parks Diesel Trucks and Equipment Citywide," June 19, 2007.

⁶ Gerhard Knothe, "Biodiesel and renewable diesel: A comparison," National Center for Agricultural Utilization Research, Agricultural Research Service, U.S. Department of Agriculture, December 2009, accessed June 2013, <http://naldc.nal.usda.gov/download/39385/PDF>.

2.1.1.3 Cellulosic Diesel

Cellulosic diesel is defined as type of renewable diesel produced from complex sugars found in plants (cellulose, hemicellulose, and lignins). The fuel must have 60 percent or less of the lifecycle GHG emissions of the gasoline or diesel fuel it displaces. Currently, the only facility in the U.S. producing cellulosic diesel is KiOR in Mississippi.⁷ Based on conversations with a KiOR representative, all of the fuel is committed to existing offtake agreements with end-users such as FedEx, and it is unlikely any of the fuel is will be sold to the NYC market in the near future.⁸ However, it is expected that the production of cellulosic diesels will continue to grow in coming years. EPA estimates that 4.56 billion gallons of cellulosic diesel will be produced from biomass-to-liquids (from Fischer-Tropsch processes – 1.96 billion gallons) or other cellulosic diesel processes by 2022.⁹ Cellulosic diesel also meets the fuel specification requirements of the ASTM International D975 standard for 100 percent petroleum diesel fuel, so, similar to renewable diesel, it can be blended with petroleum diesel at any point in the diesel fuel distribution system at any blend ratio.

2.1.2 Feedstock Sources for Biomass-Based Diesel

The purpose of this section is first to identify feedstocks used in biodiesel and renewable diesel and second, to assess the availability of these feedstocks in New York City (NYC). Primary feedstocks for biodiesel include: 1) soy oil, canola, and corn oils; 2) waste vegetable oils (yellow/brown grease); 3) advanced oils: algae, jatropha, palm oils; and 4) other fats and oils such as rendering fats (including tallow, white grease, and poultry fats) and other food-based oils. Primary feedstocks for renewable diesel (ASTM D975) include: 1) vegetable oils; 2) rendering fats; and 3) “other” biomass. Other feedstocks, while not as popular as those previously listed, include all other variations of fish oils, sunflower, rapeseed, and cottonseed. Lastly, primary feedstocks for cellulosic diesel include woody or fibrous plant material.

Many of these feedstocks are readily available in NYC, however, NYC fleet vehicles are currently employing biodiesel produced solely from soybeans. Due to the current high price of soybeans in the United States,¹⁰ as well as the significant availability of brown and yellow grease in NYC, this report will concentrate on waste oil feedstocks.

However, a status brief is provided below for all feedstocks used in biomass-based diesels. These feedstocks can be used for both biodiesel and renewable diesel production.

2.1.2.1 Traditional Virgin Oils

2.1.2.1.1 Soybeans

In the United States, soybeans are the most common feedstock used in the production of biodiesel. They consistently produce high quality biodiesel due to their low free-fatty acid content, which typically ranges

⁷ KiOR, “Production Facilities,” accessed June 2013, <http://www.kior.com/content/?s=6&s2=56&p=56&t=Production-Facilities>.

⁸ Conversation with Adam Youngman, KiOR, Advanced Biofuels Leadership Conference, April 15, 2013.

⁹ EPA, “Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis,” pg. 71.

¹⁰ USDA, “Oil Crops Outlook”, 2013, accessed June 2013, <http://usda01.library.cornell.edu/usda/ers/OCS//2010s/2013/OCS-02-12-2013.pdf>.

from 1 to 4 percent¹¹, and as a result, can be processed into biodiesel more easily than waste oils. While soybeans face similar insect and pest problems as other crops, they also have less nutrient requirements than other crops and can be grown in soils similar to those used in corn production. Because of these similar soil requirements, soybeans can be planted in rotation with corn throughout the year. In addition, no crops are solely grown for biodiesel production, so soybean production does not require land clearing. It is also important to note that only the oil portion of the soybean is used for biodiesel production, so the remainder of the soybean can be used for livestock and human sustenance. “In 2010, U.S. biodiesel produced from soybean oil co-produced enough soybean meal for 57 billion servings of protein like those used in global hunger programs,” stated Jim Hershey from the World Initiative for Soy in Human Health.¹²

In 2011, biodiesel production from soybean oil represented more than half of total U.S. production volumes.¹³ While most soybean production occurs in the upper Midwest, New York as a state produced 11.91 million bushels of soybeans in 2011.¹⁴ Per the National Biodiesel Board, one bushel of soybeans can produce 1.5 gallons of biodiesel; therefore, New York could have produced 17.865 million gallons of biodiesel in 2011. The price of soybeans is currently extremely high in comparison with other feedstocks, but these high prices may be mitigated by eliminating high shipping prices through the use of local soybean crops in New York.

2.1.2.1.2 Corn

As recently as 2010, about 10 percent of biodiesel produced in the United States was produced using corn oil. Per the National Biodiesel Board (NBB), 315 million gallons of biodiesel was produced in the United States in 2012, so based on the above production data, around 31 million gallons of biodiesel was produced from corn oil in 2012.¹⁵ In addition, in 2008, New York produced 92,160 thousand bushels of corn.¹⁶

Corn oil is a byproduct of corn ethanol production process and is not fit for human consumption. Traditionally this type of corn oil has been used as a protein supplement for the animal feed industry. To extract corn oil from the distillers grains produced during the ethanol production process generally requires retrofitting an ethanol plant; however, anecdotal evidence suggests the payback on the equipment – reflecting the capital investment and current market prices for corn oil – is less than two years. While the majority of ethanol production facilities are new to the process of extracting corn oil for biodiesel production, it promises to become a high-value feedstock in the U.S. biodiesel market.

¹¹ Oak Ridge National Laboratory (ORNL), “Brown Grease to Biodiesel”, May 1, 2008, accessed June 2013, <http://info.ornl.gov/sites/publications/Files/Pub10998.pdf>.

¹² American Soybean Association, “State Soy Crop Statistics – Soybean Production by State 2011,” accessed June 2013, http://www.soystats.com/2012/page_15.htm.

¹³ National Biodiesel Board, “Feedstock”, accessed June 2013, <http://nbb.org/results/project-showcase/feedstock>.

¹⁴ American Soybean Association, “State Soy Crop Statistics – Soybean Production by State 2011,” accessed June 2013, http://www.soystats.com/2012/page_15.htm.

¹⁵ Biodiesel Magazine, “Biodiesel from Corn Oil: A Growing Force”, 6 July 2011, accessed June 2013, <http://www.biodieselmagazine.com/articles/7887/biodiesel-from-corn-oil-a-growing-force>.

¹⁶ The Corn Refiners Association, “U.S. Corn for Grain: Acreage, Yield, and Production”, accessed June 2013, <http://www.corn.org/publications/statistics/u-s-corn-production/>.

2.1.2.1.3 Canola

Canola is an oilseed flowering crop composed of around 44 percent oil - an oil composition higher than many other oilseed crops, including soybeans. Like soybeans, canola seed remnants can be used to produce canola meal, which is an extremely attractive animal feed. When looking at canola crop yields, long-term yields are at about 26.6 bushels per acre; however, the past few years have shown yields around 30 bushels per acre.¹⁷ Currently, about 1.5 million acres of canola are grown in the United States, mainly concentrated in Montana, Oregon, Idaho, Montana, Minnesota, and Oklahoma.¹⁸ In 2011, canola oil accounted for approximately four percent of the biodiesel production and seven percent in 2012.¹⁹

2.1.2.1.4 Jatropha Oil

Jatropha curcas is an oil-bearing, uncultivated, poisonous, tropical shrub, whose seeds can be used for biodiesel production. *Jatropha* grows in dry, hot environments, typically in Asia and Africa, and is extremely resilient due to its ability to grow in regions prone to drought as well as the fact that scavenger animals are not attracted to its leaves. The *jatropha* seed has an oil content in the range of 30 to 50 percent when compared to the weight of the seed itself, which presents excellent yield results when processed into biodiesel.²⁰ Considering its high oil content and resiliency, this feedstock is a desirable feedstock for biodiesel production in some regions of the world, however, in the case of feedstock supply for New York City, *jatropha* is an unlikely choice because of its far proximity from NYC and the high associated costs of shipping.

2.1.2.1.5 Algae Oil

Algae oil can be used to produce both biodiesel and diesel fuel, however its high capital cost shows barriers to widespread commercial production for either fuel. According to a study conducted by NREL, the only way to make production of algal oil for transportation fuel use cost effective, is to cultivate the native algae with fertile "...open ponds, capable of producing 30 grams of algae per square meter per day, at 30 percent lipids content (yielding 4,000 gallons of biodiesel fuel per acre annually) ..."²¹ Algae has also been cultivated in fully enclosed containers (also known as photo-bioreactors) but containment presents another series of challenges such as nutrient delivery, harvest, and high costs for infrastructure.

As of March 2013, no commercially-produced algae-based biodiesel had been reported in the United States.²² However companies, such as Sapphire Energy and Solazyme, are continuing to make strides in algae research and development. Sapphire Energy is currently producing 100 barrels of green crude oil each day at a demonstration facility and plans to break ground for the commercial facility in 2016.²³

¹⁷ Biodiesel Magazine, "Count on Canola for Your Biodiesel", January 17, 2008, accessed June 2013, <http://www.biodieselmagazine.com/articles/2063/count-on-canola-for-your-biodiesel/>.

¹⁸ U.S. Canola Association, "What is Canola", <http://www.uscanola.com/what-is-canola/>.

¹⁹ Form EIA-22M – Monthly Biodiesel Production Survey, accessed March 2013, http://www.eia.gov/survey/form/eia_22m/proposed/form.pdf.

²⁰ International Journal of Molecular Sciences, "Non-Edible Plant Oils as New Sources for Biodiesel Production", February 8, 2008, accessed June 2013, <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2635661/>.

²¹ NREL, "Algae as a Biodiesel Feedstock: A Feasibility Assessment: Draft," November 20, 2007, accessed June 2013, <http://www.afdc.energy.gov/pdfs/algae.pdf>.

²² Form EIA-22M – Monthly Biodiesel Production Survey, accessed March 2013, http://www.eia.gov/survey/form/eia_22m/proposed/form.pdf.

²³ Mary Rosenthal, Algae Biomass Organization, Presentation, Advanced Biofuels Leadership Conference, April 15, 2013.

Solazyme, which produces a biodiesel, renewable diesel, and aviation fuel from a micro-algae which requires no sunlight (eutrophic), sold biodiesel through Propel Fuels during a 30-day trial in February 2013.²⁴

2.1.2.2 Animal-Based and Waste Oils

2.1.2.2.1 Yellow Grease

Yellow grease is traditionally includes fats and oils (also known as lipids) from used cooking oil or other lipids collected from commercial or industrial cooking operations.²⁵ It contains around 4-15 percent free fatty acids, and is much easier to process into biodiesel than brown grease.²⁶ As such, yellow grease is much more desirable for biodiesel production. New York City is ideal for yellow grease collection due to the ample amount of restaurants in the city producing fryer grease daily. In addition, yellow grease collection can be monitored relatively easily as the transport of grease from commercial establishments must be performed by a trade waste hauler licensed by New York City Business Integrity Commission (BIC), per NYC law. As of April, 2013, 29 BIC-licensed grease haulers (for both yellow and brown grease) were operating in NYC, servicing approximately 17,000 commercial and institutional establishments. Appendix 7, lists grease haulers in NYC as of March 15, 2013.

In 2011, NYC BIC licensed haulers collected nearly 8.3 million gallons of yellow grease in the city.²⁷ Illegal grease hauling in the city has expanded recently due to the desirability of yellow grease as a feedstock in biodiesel and the low cost of hauling grease. These illegal haulers will identify establishments in the city who will either pay to have their grease traps cleared or will allow their grease traps to be cleared at no cost to the hauler and will sell the grease for monetary gain.

²⁴ Propel, "Soladiesel Algae-Based Fuel Drives Successful Consumer Trial at Propel Fuels Locations, March 5, 2013, accessed June 2013, http://propelfuels.com/news_and_media/press_releases/soladiesel_algae_based_fuel_drives_successful_consumer_trial_at_propel_fuel/.

²⁵ T. Moore & E.H. Myers, "An Assessment of the Restaurant Grease Collection and Rendering Industry in South Carolina," September 2010, accessed June 2013, http://www.energy.sc.gov/publications/Assessment_of_Restaurant_Grease_Report-Summer_2010%20_updated.pdf.

²⁶ Oak Ridge National Laboratory (ORNL), "Brown Grease to Biodiesel", May 1, 2008, accessed June 2013, <http://info.ornl.gov/sites/publications/Files/Pub10998.pdf>.

²⁷ New York City, Business Integrity Commission and Department of Environmental Protection, "NYC Business Integrity Commission, Department of Environmental Protection, and Mayor's Office of Policy and Strategic Planning Launch Comprehensive Strategy to Help Businesses Comply with Grease Disposal Regulations", October 18, 2012, accessed June 2013, http://www.nyc.gov/html/bic/downloads/pdf/pr/nyc_bic_dep_mayoroff_policy_10_18_12.pdf.

Dealing with Illegal Grease Hauling Activities

To discontinue and dissuade these illegal hauling activities, on October 18, 2012, the NYC BIC and NYC Department of Environmental Protection (DEP) launched a grease hauling and disposal regulations compliance strategy.²⁸ The interagency program included a joint BIC and DEP task force and an educational DEP online video on how to keep out grease, fats, and oils from the City's sewer system. Illegal haulers will be heavily fined by BIC and encouraged to obtain a license. In addition, businesses illegally disposing grease or hiring non-licensed grease haulers will be ordered to discontinue disposal practices and required to subsequently use a licensed hauler.

There are two routes that legally hauled grease can take after it is collected from grease traps - it can either be sold to a refiner that is licensed by the New York Department of Environmental Conservation (DEC) or sold directly to a biodiesel manufacturer. There are currently three licensed grease refiners operating in NYC and a small scattering of refiners operating in areas around NYC. These refiners clean and filter the grease where it is then sent to a processing plant, such as a biodiesel production facility or pet food production facility. Processing plants are not overseen by the NYC DEC so whether the processed grease is turned into animal feedstock or biodiesel is not certain.

2.1.2.2.2 Brown Grease

Brown grease traditionally includes oil collected from grease traps, which are tanks designed to separate grease and oil from water prior to entering the sewer system and are installed in commercial, industrial or municipal sewage facilities (e.g. restaurants).²⁹ In 2011, 1.8 million gallons of brown grease was collected by licensed haulers.³⁰ When restaurant grease interceptors are not cleared regularly, fats, oils, and greases (FOGs) overflow into the sewer system, often causing blockages and sewer back-ups. In NYC, improperly disposed-of grease (including brown and yellow grease) accounts for 61 percent of sewer backups.³¹ In addition, DEP removed over 30 million pounds of sediment and debris from NYC sewers from 2010 to 2012, which contributed to about two million gallons of extra sewer capacity.³² FOGs that are not collected in grease traps, as a result of trap overflow, must then be captured, processed, and

²⁸ New York City, Business Integrity Commission and Department of Environmental Protection, "NYC Business Integrity Commission, Department of Environmental Protection, and Mayor's Office of Policy and Strategic Planning Launch Comprehensive Strategy to Help Businesses Comply with Grease Disposal Regulations", October 18, 2012, accessed June 2013, http://www.nyc.gov/html/bic/downloads/pdf/pr/nyc_bic_dep_mayoroff_policy_10_18_12.pdf.

²⁹ T. Moore & E.H. Myers, "An Assessment of the Restaurant Grease Collection and Rendering Industry in South Carolina," September 2010, accessed June 2013, http://www.energy.sc.gov/publications/Assessment_of_Restaurant_Grease_Report-Summer_2010%20updated.pdf.

³⁰ New York City, Business Integrity Commission and Department of Environmental Protection, "NYC Business Integrity Commission, Department of Environmental Protection, and Mayor's Office of Policy and Strategic Planning Launch Comprehensive Strategy to Help Businesses Comply with Grease Disposal Regulations", October 18, 2012, http://www.nyc.gov/html/bic/downloads/pdf/pr/nyc_bic_dep_mayoroff_policy_10_18_12.pdf.

³¹ New York City, Business Integrity Commission and Department of Environmental Protection, "NYC Business Integrity Commission, Department of Environmental Protection, and Mayor's Office of Policy and Strategic Planning Launch Comprehensive Strategy to Help Businesses Comply with Grease Disposal Regulations", October 18, 2012, http://www.nyc.gov/html/bic/downloads/pdf/pr/nyc_bic_dep_mayoroff_policy_10_18_12.pdf.

³² New York City, Business Integrity Commission and Department of Environmental Protection, "NYC Business Integrity Commission, Department of Environmental Protection, and Mayor's Office of Policy and Strategic Planning Launch Comprehensive Strategy to Help Businesses Comply with Grease Disposal Regulations", October 18, 2012, http://www.nyc.gov/html/bic/downloads/pdf/pr/nyc_bic_dep_mayoroff_policy_10_18_12.pdf.

disposed of in wastewater treatment plant (WWTP) facilities. As of 2013, 14 waste water treatment plants are operating in NYC,³³ together processing over 1.3 billion gallons of waste water daily.³⁴

As waste water (also called influent) enters the WWTP, trash is removed through a preliminary screening process, and the remaining water is transferred to a primary settling tank. The treatment process once in the primary settling tank varied slightly by WWTP, however, the general process is the same. Once water flow is slowed, the sedentary water allows heavy solids to drop out and lighter greases to float to the surface. Grease is then scraped off of the surface using a rake like piece of equipment, which pushes grease to one side of the tank where it is then filters through a series of “flights” where excess water can drip away. At the bottom of the flights is a scum container where grease is kept momentarily to allow for further water drop out. At this point in the process, the grease has the consistency of peat moss and contains about 30-50 percent water. Grease is then scooped up into containers and moved to the collection area of the plant. After surveying numerous WWTPs in NYC, data suggests that most if not all of the facilities in NYC have their grease hauled out after processing for disposal at landfills. As the grease is separated from other solid waste before being disposed of, there is strong potential for grease collection before other solids are delivered to the landfill. In total, four of the 14 WWTPs in NYC were surveyed to learn more about their overall grease capturing process, the amount of grease they collect weekly, and how they dispose of the grease collected. Across the board, the cost of brown grease disposal for WWTPs in NYC is \$70 per ton. Amounts of grease collected per week varied by WWTP due to district size and the volume of wastewater flowing into the plant. Exhibit 2 below shows brown grease collection volumes and capacity information for each of the 14 WWTPs in NYC.

Exhibit 2: Wastewater Treatment Plants in NYC

Wastewater Treatment Plant	Borough	Design Flow (MGD)	Grease Collection (gallons/week)
26th Ward	Queens	85	1,100
Bowery Bay	Queens	150	800
Coney Island	Brooklyn	110	2,300
Hunts Point	Bronx	200	200
Jamaica	Queens	100	2,500
Newtown Creek	Brooklyn	310	1,000
North River	Manhattan	170	1,400
Oakwood Beach	Staten Island	40	0
Owls Head	Brooklyn	120	3,200
Port Richmond	Staten Island	60	300
Red Hook	Brooklyn	60	400

³³ Current wastewater treatment plants (WWTPs) in NYC include: 26th Ward WWTP, the Coney Island WWTP (Brooklyn), Jamaica WWTP (Queens), Wards Island WWTP (Manhattan), Bowery Bay WWTP (Queens), Tallman Island WWTP (Queens), Hunts Point WWTP (Bronx), Oakwood Beach WWTP (Staten Island), Port Richmond WWTP (Staten Island), Rockaway WWTP (Brooklyn), Owls Head WWTP (Brooklyn), Newtown Creek WWTP (Brooklyn), Spring Creek auxiliary plant connected to the 26th Ward WWTP (Brooklyn), Red Hook WWTP (Brooklyn), and the North River WWTP (positioned on a platform on the Hudson River). New York City Department of Environmental Protection, “New York City’s Wastewater Treatment System”, <http://www.nyc.gov/html/dep/pdf/wssystem.pdf>

³⁴ New York City, “New York City’s Wastewater”, <http://www.nyc.gov/html/dep/html/wastewater/index.shtml>

Wastewater Treatment Plant	Borough	Design Flow (MGD)	Grease Collection (gallons/week)
Rockaway	Queens	45	100
Tallman Island	Queens	80	400
Wards Island	Manhattan	275	6,200
	TOTAL	1,805	19,900

Source: NYC Department of Environmental Protection (DEP), 2013. *Gallons of grease collected is estimated based on number of 6 cubic yard containers of grease removed using the conversion factor of 1 cubic yard = 202 gallons.

With grease already extracted from the sewage sludge, pretreatment of the waste grease for biodiesel production is less intensive than with non-treated waste water, however, the process still involves numerous steps. The first step involves degumming to reduce phosphatide levels, followed by bleaching to absorb traces moisture, metals, insolubles, and pigments. In addition, bleaching also reduces oxidation products. The final step in producing biodiesel is deodorizing and deacidification which removes 92-95 percent of free fatty acids (FFAs; brown grease contains 50-100 percent free fatty acids), aldehydes, ketones, and odor. To convert FFAs to fatty acid methyl esters, methanol is added to the product and finally, triglycerides are converted to biodiesel through transesterification.³⁵ With regard to brown grease processing plants for biodiesel production, the United Metro Energy Corp. announced in March 2013 that they were acquiring ownership of all New York fuel distribution and terminating assets previously belonging to Metro Terminals. The United Metro Energy Corp. will be finishing construction of the 90 percent completed biodiesel blending terminal in Brooklyn, which could allow for the brown grease collected in the city to be processed into biodiesel in a local terminal, saving shipping costs.³⁶

2.1.2.2.3 Choice White Grease, Beef Tallow, and Poultry Fat

Choice white grease, beef tallow, and poultry fat are all by-products of animal mortality processing. Currently, rendered animal fats make up nearly one-third (11.6 billion gallons) of the United States' lipid production, and vegetable oils make up the remaining two-thirds of production (22.4 billion gallons), making animal fat a viable feedstock option as biodiesel producers look to find additional feedstock supplies.³⁷ In 2012, animal fat-based biodiesel comprised approximately 13 percent of total biodiesel production in the United States.³⁸

Lipids are a group of naturally occurring molecules that include the subgroup, triglycerides (fat molecules that can be processed into biodiesel). Since this supply source is generally well established in the United States due to the high rate of animal consumption, these greases can be collected and sold by rendering plants and by the animal processors themselves. Choice white grease is a specific grade of mostly pork fat

³⁵ Oak Ridge National Laboratory (ORNL), "Brown Grease to Biodiesel", May 1, 2008, accessed June 2013, <http://info.ornl.gov/sites/publications/Files/Pub10998.pdf>.

³⁶ TankTerminal.com, "United Refining Gets Bankrupt Metro Terminals for a Song", February 8, 2013, accessed June 2013, http://www.tankterminals.com/news_detail.php?id=2199.

³⁷ Biodiesel Magazine, "Recycling for Renewables", June 21, 2007, accessed June 2013, <http://www.biodieselmagazine.com/articles/1707/recycling-for-renewables>.

³⁸ Form EIA-22M – Monthly Biodiesel Production Survey, accessed March 2013, http://www.eia.gov/survey/form/eia_22m/proposed/form.pdf.

defined by hardness, color, fatty acid content, moisture, insolubles, unsaponifiables and free fatty acids.³⁹ This grease can be collected at rendering plants from swine processing or collected directly from livestock producers, thereby reducing the material that would otherwise end up in landfills and also mitigating the chance of water contamination from livestock decomposition. Tallow is a rendered product of beef or mutton fat, which is solid in consistency and high in free fatty acid content. While tallow's free-fatty acid content is similar to other animal-based feedstocks, it does require slightly more processing than other feedstocks due to its consistency. Another animal-based biodiesel feedstock that can be produced at low costs and with high sustainability, is poultry fat. As a by-product of the chicken rendering process, it is easily collected and readily available in the commercial market. According to the U.S. Department of Agriculture (2002), there are 2.2 billion pounds of inedible poultry fat rendered each year.⁴⁰ As such, animal fats are currently an extremely viable option for increasing biodiesel feedstock supplies. Additionally, by increasing the demand for animal-based feedstocks for use in biodiesel production, rendering companies will increase the amount of livestock mortalities they process, which is both environmentally and economically beneficial.⁴¹

2.2 Environmental Benefits and Issues for Biomass-Based Diesel

Compared to petroleum diesel, biodiesel offers many positive environmental benefits. From an air quality standpoint, biodiesel can substantially reduce the volume of tailpipe emissions released from an on-road vehicle, and these emissions reductions increase as the amount of biodiesel blended into the fuel increases. In addition, biodiesel is less toxic than petroleum diesel and therefore is extremely attractive for environmentally sensitive geographic regions.

2.2.1 Greenhouse Gas Emissions from Biomass-Based Diesel and Heating Oil Substitutes

With regard to emissions produced from biomass-based diesel fuels, it is important to note that greenhouse gas (GHG) emission levels, including carbon dioxide [CO₂], methane, and nitrogen oxide [NO_x], may vary substantially depending on feedstock based on a number of factors. However, for GHG emission accounting, DCAS attributes zero emissions from biodiesel consumption as it is a "biogenic" carbon.⁴² The EPA defines biogenic carbon as emissions from a source "directly resulting in the combustion or decomposition of biologically-based materials other than fossil fuels."⁴³ This distinction between feedstocks and their effect on GHG emissions can be attributed to the fact that crop-based diesels are able to mitigate future GHG emissions through CO₂ sequestration during cultivation. When crop-based biodiesel is burned in a vehicle, the CO₂ is released into the atmosphere; however, this CO₂ is absorbed when a new soybean plant grows. The capture of the total "well to wheels" emissions from growing, harvesting, transporting, processing, and using the fuel, is prepared as part of a lifecycle

³⁹ United States Department of Agriculture, "Thesaurus and Glossary Home", accessed June 2013, <http://agclass.nal.usda.gov/agt.shtml>.

⁴⁰ G.G. Pearl, 2006, "Rendering 101: Raw Material, Rendering Process, and Animal By-Products, Render"

⁴¹ Marketing Services Division Minnesota Department of Agriculture, "The Feasibility of Biodiesel from Waste/Recycled Greases and Animal Fats", October 2002, accessed June 2013, http://www.angelfire.com/ks3/go_diesel/files042803/wastefatsfeasability.pdf.

⁴² Interview with Emily Small, Department of Citywide Administrative Services, May 8, 2013. The emission factors are derived from a GHG inventory report prepared by OLTPS as part of the December FY11 inventory, published in December 2012.

⁴³ EPA, "Carbon Dioxide Accounting for Emissions from Biogenic Sources," accessed June 2013, <http://yosemite.epa.gov/sab/sabproduct.nsf/0/2F9B572C712AC52E8525783100704886>.

analysis. Because no new CO₂ is added to the atmosphere, crop-based diesels are considered “carbon neutral” and are a great alternative to petroleum-based diesel fuel.

Other government entities, such as the California Air Resources Board, have defined GHG emissions associated with various types of biomass-based diesels. For example, as part of the California Low Carbon Fuel Standard (LCFS), the ARB developed a carbon intensity table for biodiesel (among other fuels) and attributed the direct emissions (gCO₂e/MJ) as well as any associated Indirect Land Use Change (ILUC) emissions (associated with converting land to grow a crop).⁴⁴ Though soybean-based biodiesel produces significantly less tailpipe emissions compared to conventional petroleum-based fuels, they do have a high ILUC associated with converting land to grow the soybeans. Other feedstocks, such as used vegetable oil and corn oil, have a significantly lower carbon intensity because they are considered waste products and do not have any attributable land use requirements. According to ARB, in total, GHG emissions in on-road vehicles can be reduced by 15 to 96 percent compared to ULSD.⁴⁵

Biodiesel from animal-based feedstocks emit slightly more CO₂ than their plant-based biodiesel competitors when used in boilers, releasing about 271 pounds of CO₂ per hour, where soy-based biodiesel emits 268 pounds of CO₂ per hour. Note that biodiesel, regardless of feedstock, emits less CO₂ than petroleum-based diesel when used in boilers. On the other hand, biodiesel results in more unburned hydrocarbons (HC), carbon monoxide (CO), sulfates, nitrogen oxides, and oxygen emissions than petroleum-based diesel, when burned in boilers.

Exhibit 3 below shows this difference in emissions by feedstock origin.

Exhibit 3: Emission Differences between Petroleum-Based Diesel, Soy-Based Biodiesel, and Animal-Based Biodiesel when used as Fuel Oil in Boilers (pounds per hour)

	O ₂	CO ₂	CO	NO _x	NO	SO ₂	HC
No. 2 Distillate	31.9	317	0.00328	0.188	0.182	0.0582	0.000603
Soy Biodiesel	28.3	268	0.00539	0.21	0.208	0.00873	-0.000794
Animal Biodiesel	34.2	271	0.00611	0.221	0.219	0.00613	-0.00577

Source: EPA, 2009.⁴⁶

⁴⁴ CARB, “Table 7: Carbon Intensity Lookup Table for Diesel and Fuels that Substitute for Diesel,” December 2012, accessed June 2013, http://www.arb.ca.gov/fuels/lcfs/lu_tables_11282012.pdf.

⁴⁵ CARB, “Table 7: Carbon Intensity Lookup Table for Diesel and Fuels that Substitute for Diesel,” December 2012, accessed June 2013, http://www.arb.ca.gov/fuels/lcfs/lu_tables_11282012.pdf.

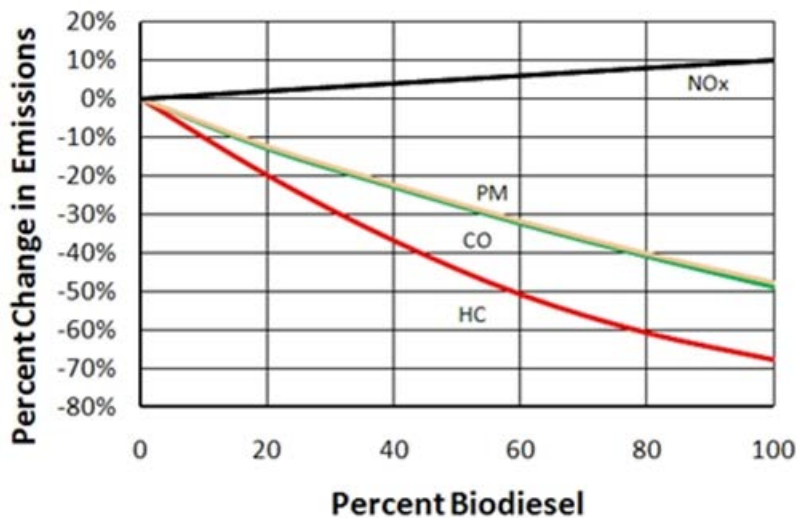
⁴⁶ EPA, “Characterizing Emissions from the Combustion of Biofuels”, September, 2008, accessed June 2013, <http://nepis.epa.gov/Exe/ZyNET.exe/P1009IYE.txt?ZyActionD=ZyDocument&Client=EPA&Index=2006%20Thru%202010&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&UseQField=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5CZYFILES%5CINDEX%20DATA%5C06THRU10%5C TXT%5C00000023%5CP1009IYE.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=p%7Cf&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=19>

Other Emissions from Biomass-Based Diesel and Heating Oil Substitutes

Regardless of feedstock, emissions of HCs, CO, sulfates, polycyclic aromatic hydrocarbons, nitrated polycyclic aromatic hydrocarbons, and particulate matter (PM) from on-road vehicles have been shown to decrease dramatically as the biodiesel blend level increases.

B20 (20 percent biodiesel, 80 percent petroleum diesel) can potentially reduce PM emissions by 10 percent, CO by 11 percent, and unburned HC by 21 percent (see graph).⁴⁷ Per the NREL *Biodiesel Handling and Use Guidelines* report (fourth edition (revised)), these reductions in HCs, CO, sulfates, polycyclic aromatic hydrocarbons, nitrated polycyclic aromatic hydrocarbons, and PM can be attributed to the 11 percent oxygen content of biodiesel. High fuel oxygen levels help fuel burn more thoroughly than conventional fuels, thereby reducing the amount of emissions that are left behind in the tailpipe. Unlike CO₂, emissions levels of PM, HCs, and CO do not fluctuate based on biodiesel feedstock type.⁴⁸

Exhibit 4: Heavy-Duty Highway Engines - Average Emissions Impact of Biodiesel



Source: EPA, 2002.⁴⁹

An analysis conducted by EPA in 2002, *A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions*⁵⁰, showed that B20 used in on-road vehicles exhibited a 2 percent increase in nitrogen oxide (NO_x) over petroleum-based fuels. However, a report published by NREL in 2006 titled *Effects of Biodiesel Blends on Vehicle Emissions*, suggests that biodiesel use, B20 specifically, exhibits no statistically significant net impact on NO_x emissions.⁵¹ Reinforcing NREL's findings, the Society of Automotive Engineers (SAE) published a report in 2009, *Biodistillate Transportation Fuels 2-Emissions*

⁴⁷ AFDC, "Biodiesel Benefits and Considerations," accessed June 2013, http://www.afdc.energy.gov/fuels/biodiesel_benefits.html.

⁴⁸ NREL, *Biodiesel Handling and Use Guide, Fourth Edition (Revised)*, January 2009, accessed June 2013, <http://www.nrel.gov/vehiclesandfuels/pdfs/43672.pdf>.

⁴⁹ EPA, "A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions", October 2002, accessed June 2013, <http://epa.gov/otag/models/analysis/biodsl/p02001.pdf>.

⁵⁰ EPA, "A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions", accessed June 2013, <http://epa.gov/otag/models/analysis/biodsl/p02001.pdf>.

⁵¹ National Renewable Energy Laboratory, "Effects of Biodiesel Blends on Milestone Report - Vehicle Emissions", October 2006, accessed June 2013, <http://www.prometheanbiofuels.com/docs/nrelemmissionsrep06.pdf>.

Impacts, finding B100's NO_x emissions to be in the 2 to 3 percent range over petroleum based fuels.⁵² NREL examined the conflicting results in 2009 and found that the effect of biodiesel on NO_x emissions can vary with engine design, calibration, and test cycle.

In contrast to the effects of biodiesel use in on-road vehicles, biodiesel use in boilers, or bioheat use, leads to a decrease in NO_x emissions.⁵³ NO_x emissions from boilers less than 100 Million Btu/hr are approximately 20 lbs per 10,000 gallons for No. 2 oil and 55 lbs per 10,000 gallons for No. 6 oil.⁵⁴ As the biodiesel blend level increases, NO_x emissions decrease linearly. With every 1 percent increase in biodiesel blend level, there is a corresponding 1 percent decrease in NO_x emissions. This difference in emissions can be contributed to the differences in the combustion process. While a boiler burns biodiesel using an open flame, a diesel internal combustion engine ignites biodiesel relying on the heat of compression. In addition to NO_x reductions, biodiesel use also reduces SO_x emissions due to the fact that biodiesel contains lower levels of sulfur than petroleum-based diesel.

With regard to volatile organic compounds (VOCs), animal-based biodiesel generally contains higher concentrations of organic compounds than soy-based biodiesel or No. 2 diesel. However, animal-based biodiesel's organic compound concentrations vary significantly based on the test at hand, so major differences in concentrations should not be considered significant. Exhibit 5 and Exhibit 6 below break down the VOC concentrations released from No. 2 diesel, animal-based biodiesel, and soy-based biodiesel. Relative standard deviations are shown for each organic compound between feedstocks.

Overall, biomass-based diesels have better air emission attributes for both on-road vehicles and boilers compared to petroleum-based diesels. The improved emissions will not just help the City meet GHG emission targets, but will also reduce other air emission problems.

⁵² SAE, "Biodistillate Transportation Fuels 2. - Emissions Impacts," accessed June 2013, <http://papers.sae.org/2009-01-2724/>.

⁵³ NREL, "Biodiesel Handling and Use Guide", Fourth Edition (Revised), January 2009, accessed June 2013, <http://www.nrel.gov/vehiclesandfuels/pdfs/43672.pdf>.

⁵⁴ EPA, "Compilation of Air Pollutant Emission Factors," Chapter 1.3: Fuel Oil Combustion, Fifth Edition, Volume I, pg. 5, accessed June 2013, <http://www.epa.gov/ttnchie1/ap42/>.

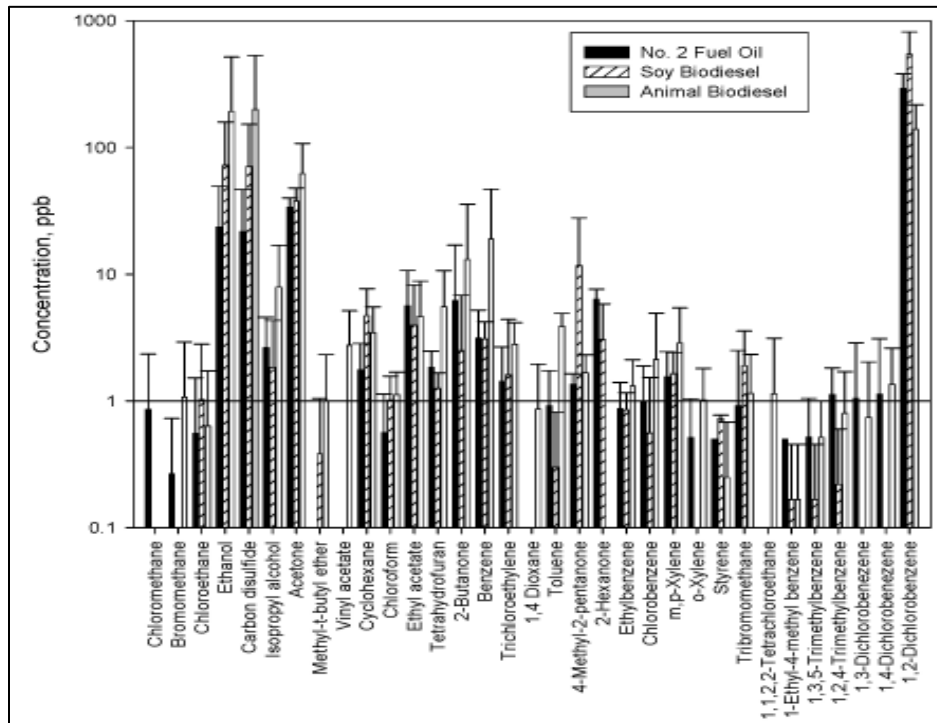
Exhibit 5: Heavy-Duty Highway Engines - Biodiesel VOC Emissions by Feedstock

	No. 2 Fuel Oil Average (Standard Deviation)	Soy Biodiesel Average (Standard Deviation)	Animal Biodiesel Average (Standard Deviation)
Chloromethane	0.860 (1.49)	ND ^(a)	ND
Bromomethane	0.267 (0.462)	ND	1.07 (1.85)
Chloroethane	0.557 (0.964)	1.03 (1.78)	0.633 (1.10)
Ethanol	23.6 (25.8)	72.6 (86.2)	193 (324)
Carbon disulfide	21.7 (24.8)	70.6 (81.9)	199 (332)
Isopropyl alcohol	< 2.64 ^(b) (1.94)	1.84 (2.49)	7.90 (9.03)
Acetone	33.7 (6.08)	37.8 (10.0)	62.1 (45.3)
Methyl-t-butyl ether	ND	0.383 (0.664)	< 1.00 (1.32)
Vinyl acetate	ND	ND	2.76 (2.39)
Cyclohexane	< 1.76 (1.09)	4.72 (2.96)	3.46 (2.06)
Chloroform	0.563 (0.575)	< 1.02 (0.553)	1.12 (0.563)
Ethyl acetate	5.65 (5.07)	3.97 (4.27)	4.68 (4.14)
Tetrahydrofuran	1.84 (0.637)	1.26 (0.406)	5.54 (5.14)
2-Butanone	6.22 (10.8)	2.50 (4.34)	13.1 (22.6)
Benzene	3.15 (2.06)	3.09 (1.12)	19.0 (27.9)
Trichloroethylene	1.43 (1.24)	1.61 (2.79)	2.81 (1.34)
1,4 Dioxane	ND	ND	< 0.863 (1.09)
Toluene	0.920 (0.817)	0.300 (0.520)	3.89 (1.02)
4-Methyl-2-pentanone	1.35 (0.289)	11.71 (16.04)	1.67 (0.644)
2-Hexanone	6.36 (1.27)	3.08 (2.74)	ND
Ethylbenzene	< 0.873 (0.530)	< 0.853 (0.307)	1.31 (0.803)
Chlorobenzene	1.00 (0.887)	0.560 (0.970)	2.13 (2.82)
m,p-Xylene	1.56 (0.890)	1.65 (0.759)	2.88 (2.55)
o-Xylene	< 0.517 (0.525)	ND	1.02 (0.779)
Styrene	< 0.500 (0.000)	0.727 (0.049)	0.250 (0.433)
Tribromomethane	0.917 (1.59)	1.90 (1.66)	1.15 (1.18)
1,1,2,2-Tetrachloroethane	ND	ND	1.14 (1.98)
1-Ethyl-4-methyl benzene	< 0.500 (0.000)	< 0.167 (0.289)	< 0.167 (0.289)
1,3,5-Trimethylbenzene	< 0.520 (0.530)	< 0.167 (0.289)	0.517 (0.480)
1,2,4-Trimethylbenzene	1.12 (0.698)	0.220 (0.381)	0.800 (0.904)
1,3-Dichlorobenzene	1.05 (1.82)	ND	0.743 (1.29)
1,4-Dichlorobenzene	1.13 (1.96)	ND	1.36 (1.26)
1,2-Dichlorobenzene	293 (88.8)	546 (271)	139 (78.3)

 Source: EPA, 2002.⁵⁵

⁵⁵ EPA, "Characterizing Emissions from the Combustion of Biofuels", September 2008, accessed June 2013, <http://nepis.epa.gov/Exe/ZyNET.exe/P1009IYE.txt?ZyActionD=ZyDocument&Client=EPA&Index=2006%20Thru%202010&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&UseQField=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5CZYFILES%5CINDEX%20DATA%5C06THRU10%5C TXT%5C00000023%5CP1009IYE.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C->

Exhibit 6: Heavy-Duty Highway Engines - Biodiesel VOC Emissions by Feedstock.



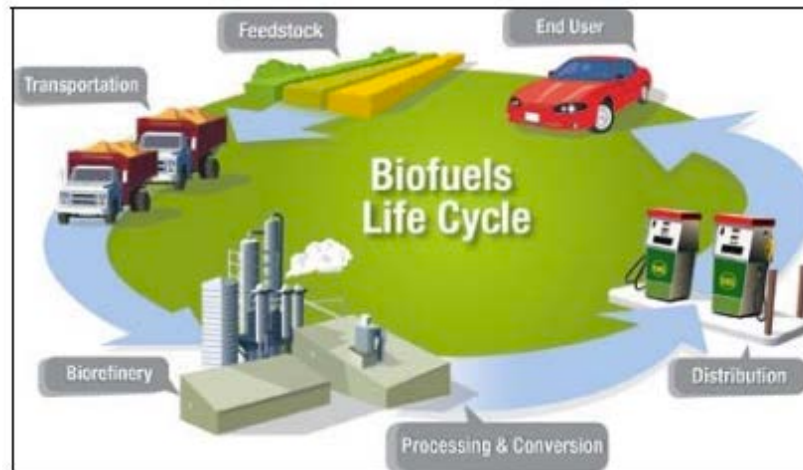
Source: EPA, 2002.⁵⁶

2.2.2 Biomass-Based Diesel Lifecycle Analysis

When comparing the lifecycle analysis (LCA) of biomass-based diesels to traditional diesel fuel, it is clear that the biomass-based diesels are far cleaner and more sustainable. As shown in the Exhibit 7 below, an LCA typically includes six different steps, including the emission impacts of: feedstock planting, growth, harvesting, and processing; transportation of the feedstock to the biorefinery; energy used to produce the biofuels, including emissions from the procession and conversion process; emissions from the distribution of the biofuels, and; the emissions from the end-use consumer. Each step involves an exchange of energy and greenhouse gas (GHG), and the total inventory of these steps creates the LCA, also known as the “well to wheels” emissions.

&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=p%7Cf&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=19
⁵⁶ EPA, “Characterizing Emissions from the Combustion of Biofuels”, September, 2008, accessed June 2013, <http://nepis.epa.gov/Exe/ZyNET.exe/P1009IYE.txt?ZyActionD=ZyDocument&Client=EPA&Index=2006%20Thru%202010&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&UseQField=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5CZYFILES%5CINDEX%20DATA%5C06THRU10%5C TXT%5C00000023%5CP1009IYE.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=p%7Cf&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=19>

Exhibit 7: Major Elements of the Biofuels Lifecycle Analysis

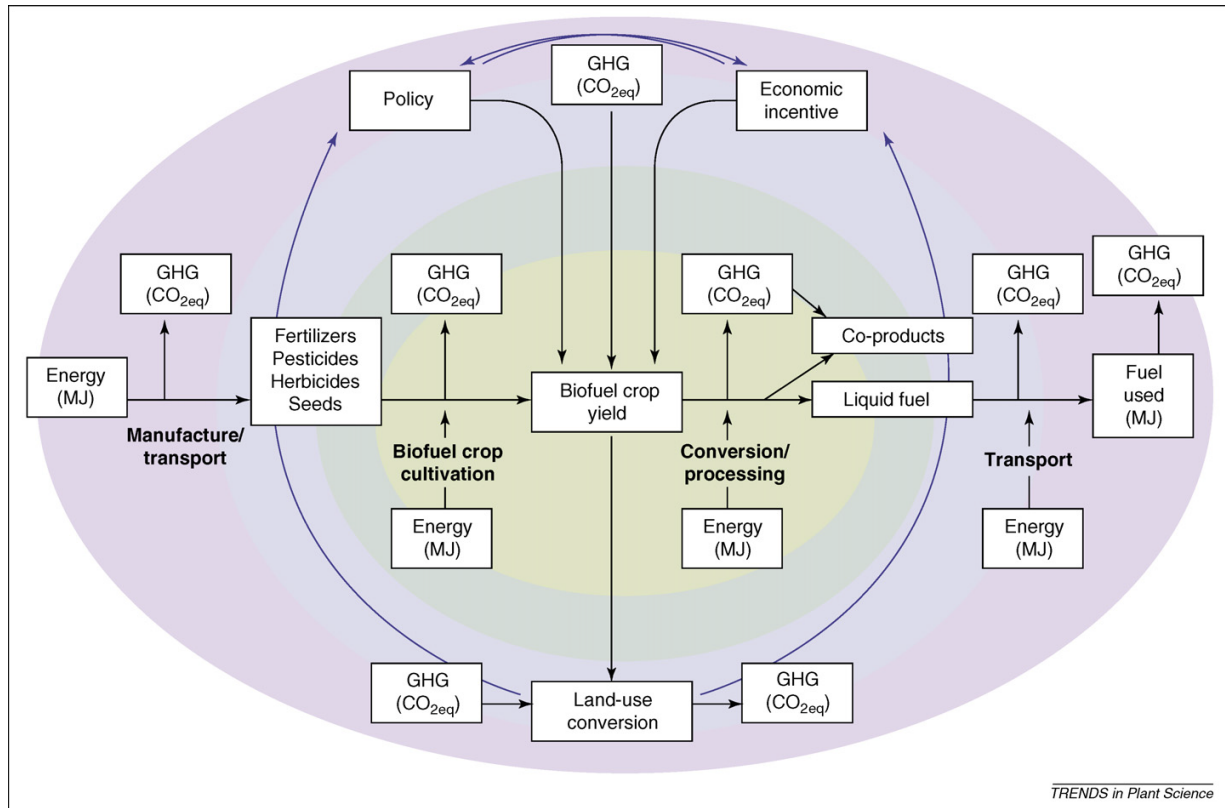


Source: National Renewable Energy Laboratory, 2010⁵⁷.

As described above, different feedstock choices lead to a wide variety of emissions variables in biomass-based feedstock. It is often difficult to determine the LCA of a particular fuel as a result of the numerous variables the fuel may have from each step in the process, and then in the end the biofuels created from multiple feedstocks could be blended together increasing the variables exponentially for the specific fuel being consumed. This creates the more detailed LCA inventory, as seen below in Exhibit 8. This shows the inputs and outputs of both energy and Greenhouse Gases into the analysis.

⁵⁷ EPA, "Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis", February 2010, Chapter 2.6, accessed August 2013, <http://www.epa.gov/otaq/renewablefuels/420r10006.pdf>.

Exhibit 8: Detailed Elements of the Biofuels Life Cycle Analysis

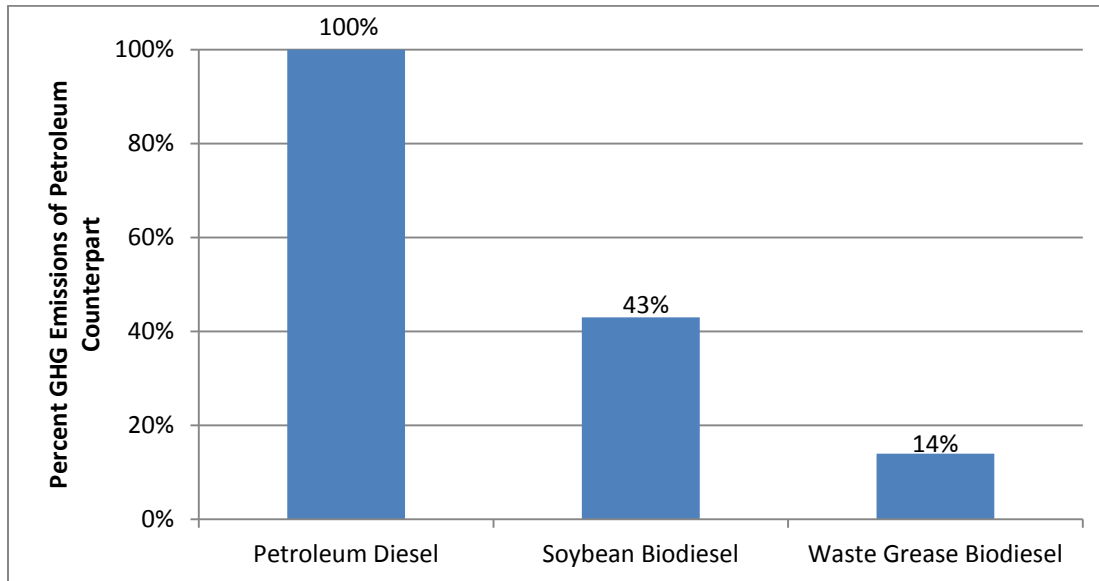


Source: Trends in Plant Science, 2009.⁵⁸

Due to the complexity of the biodiesel LCA, general assumptions are often made grouping together plant-based/soybean feedstocks versus animal-based. All types of biomass-based feedstocks produce less emissions than the LCA of petroleum-based diesel. Typically when comparing the emissions of biomass-based diesel with petroleum, petroleum emissions only include diesel combustion. The LCA emissions for petroleum-based diesel would be even greater when integrating the impacts of oil extraction, crude oil transportation to a refinery, refinery emissions, further transportation to distribution points, and final combustion.

Lifecycle emissions from biodiesel, particularly waste grease biodiesel, are dramatically reduced compared to the petroleum substitute as shown in Exhibit 9.

⁵⁸ Davis, SC, Anderson-Teixeira, KJ, and DeLucia EH, "Life-cycle analysis and the ecology of biofuels," Trends in plant science, Vol 14 (3), March 2009, p140-146, accessed August 2013, <http://www.sciencedirect.com/science/article/pii/S1360138509000478>.

Exhibit 9: Lifecycle Greenhouse Gas Emissions of Biodiesel Compared to Diesel


Source: EPA, 2010.⁵⁹

While these are high-level LCA calculations prepared by EPA for the U.S. Renewable Fuel Standard (more information below in section 2.2.4), in-depth lifecycle analysis modeling is available via the Greenhouse Gases, Regulated Emissions and Energy use in Transportation (GREET) Model developed by Argonne National Laboratory for the Department of Energy. The GREET Model is both an interactive online tool or an excel spreadsheet, that allows a user to calculate the fuel emissions based on vehicle type and miles driven. For biodiesel, the model currently only considers soybean and cellulosic feedstock pathways, although the tool is constantly evolving to include more fuel pathways. The GREET Model has shown the potential LCA emission reductions from biodiesel to be as high as 88 percent.⁶⁰

Additionally there are other versions of LCA methodologies used among national and international government agencies. Lifecycle analysis is generally contested due to the number of variables and technology advancement in both the production of fuels and the feedstock supply chain. Additionally, each LCA tool has different methodologies which are constantly changing as new data becomes available. As biodiesel production becomes more efficient in the future, LCA emissions will continue to decline.

2.2.3 Environmental Safety

Compared to petroleum diesel, which has a flashpoint of 52 degrees Celsius, biodiesel has a flashpoint greater than 150 degrees Celsius, which makes it less flammable than conventional diesel. While biodiesel is flammable, fires can be dispelled by dry chemical, foam, halon, CO₂, or water spray. In the case of a spill, biodiesel also biodegrades much more quickly than petroleum based diesel, which makes it

⁵⁹ EPA, "Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis", February 2010, Chapter 2.6, accessed August 2013, <http://www.epa.gov/otaq/renewablefuels/420r10006.pdf>.

⁶⁰ Argonne National Laboratory, "GREET Model", December 21, 2012, accessed August 2013, <http://greet.es.anl.gov/>

an attractive fuel choice for fleets in environmentally sensitive areas like wetlands and other marine environments.⁶¹

2.2.4 Renewable Fuel Standard (RFS) and Biomass-Based Diesels

The Renewable Fuel Standard (RFS1) was created by the Energy Policy Act (EPA) of 2005 and revised further in 2007 as part of the Energy Independence and Security Act (RFS2). The modified and expanded RFS2 mandates that 36 billion gallons of renewable fuel be blended into transportation fuels by 2022. The RFS2 requires obligated parties (e.g., petroleum refineries, petroleum bulk stations and terminals, and petroleum merchant wholesalers)⁶² to blend traditional fuels with a pre-determined volume of renewable fuels, increasing each year. RFS2 separated the volume requirements into four categories including: cellulosic biofuel, biomass-based diesel, advanced biofuel, and total renewable fuel. The biomass-based diesel requirements are a set-aside of a larger group of fuels known as advanced biofuels. Advanced biofuel volume requirements through 2022 were established by statute, but can be amended annually by the EPA as needed. To date, the total volume of advanced biofuels has not been altered.

Additionally, the RFS2 also changed the definition of renewable fuels to include a minimum lifecycle greenhouse gas reduction threshold and grandfathered the volume of certain facilities. New restrictions of the types of feedstocks that could be used to make renewable fuels, as well as the types of land that could be used to grow and harvest the feedstocks, were established. Finally, the new regulations included specific types of waivers and EPA-generated credits for cellulosic biofuels, to stimulate the production of more advanced biofuels. These new standards went into effect on July 1, 2010 and apply to all gasoline and diesel produced or imported. Renewable fuel producers register their product using a Renewable Identification Number (RIN), which provides a basic currency for the credit, trading, and use by obligated parties and fuel exporters to demonstrate compliance and track the volumes of renewable fuels produced and utilized to comply with the RFS2 standard.

The program is driven by the Renewable Identification Numbers (RINs⁶³), administered as ethanol-equivalent gallons produced. For every gallon of biomass-based diesel sold, the seller receives 1.5 RIN-equivalent toward the advanced biofuel requirement, but only 1 RIN towards the biomass-based diesel requirement. In total, 15 billion gallons of credits from conventional biofuels and 21 billion gallons from advanced biofuels—including 16 billion gallons from cellulosic biofuels—are required in 2022.

The RFS2 is applied at the federal level and there are no specific requirements for states. The EPA is authorized to alter the cellulosic biofuels RFS2 volumetric requirements based on the projected annual production volumes and to date have amended the requirements each year since the cellulosic biofuel requirement went into effect in 2010. For example, in 2012 the amount of required fuel was originally 250 million gallons (5.9 MMbbl) and it was reduced by EPA to 8.65 million gallons (0.21 MMbbl). However the required volumes are not separate and specific to ethanol and biomass-based diesel, but rather a combined total. Predicting the quantities of available cellulosic biofuels has proven challenging

⁶¹ NREL, “Biodiesel Handling and Use Guide”, Fourth Edition (Revised), January 2009, accessed June 2013, <http://www.nrel.gov/vehiclesandfuels/pdfs/43672.pdf>.

⁶² EPA, “2012 Renewable Fuel Standards,” 40 CFR Part 80, January 2012, p. 1320, accessed June 2013, <http://www.gpo.gov/fdsys/pkg/FR-2012-01-09/pdf/2011-33451.pdf>.

⁶³ RINs are certificates representing gallons of renewable fuels issued by the U.S. Environmental that can be sold or traded to meet obligations under the Renewable Fuels Standard. Additional information about this program can be found in the report.

for EPA. In 2011, obligated parties were required to pay approximately \$6.8 million in penalties to the U.S. Treasury for not blending the required 6.6 million gallons (0.16 MMbbl) of cellulosic ethanol, even though those volumes were not commercially available that year. It is unclear what the revised cellulosic biomass-based diesel and ethanol requirements will be for 2013 and beyond, but given the uncertainty of commercial-scale deployment, it is likely the requirements will continue to be amended for at least the next several years.

EPA estimates that 4.56 billion gallons of cellulosic diesel will be produced from biomass-to-liquids (from Fischer-Tropsch processes – 1.96 billion gallons) or other cellulosic diesel processes by 2022.⁶⁴

New York City's initiatives to grow the use of biodiesel in NYC will clearly support achieving the RFS2 goals. NYC already is using biodiesel in heating oil and in city fleets, and these initiatives will be further expanded. NYC's acceptance of the use of biodiesel will attract obligated parties to this market since they see a positive environment for the use of biodiesel.

⁶⁴ EPA, "Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis," pg. 71.

3 New York City Initiatives to Biomass-Based Diesel

3.1 Biomass-Based Diesel Programs in New York City

The City of New York has one of the largest municipal fleets in the country with 26,000 vehicles, of which approximately 25 percent use alternative transportation fuels, including biodiesel, natural gas, electrics and hybrids.⁶⁵ The City also procures 75 million gallons of fuel annually, making it one of the largest fuel buyers in the area.⁶⁶ In 2012, the City operated 9,074 diesel units. Biodiesel blends were being used in 6,100 of those units (approximately 68 percent). Additionally, the City has integrated novel uses of biodiesel with other advanced vehicle technologies, such as using biodiesel in hybrid diesel electric units, combining emissions reduction technologies. Photos of these vehicles are shown in Exhibit 10 below.

Exhibit 10: Biodiesel and Hybrid Diesel Electric vehicles used by the NYC Fleet



Source: Department of City Administrative Services, 2012.⁶⁷

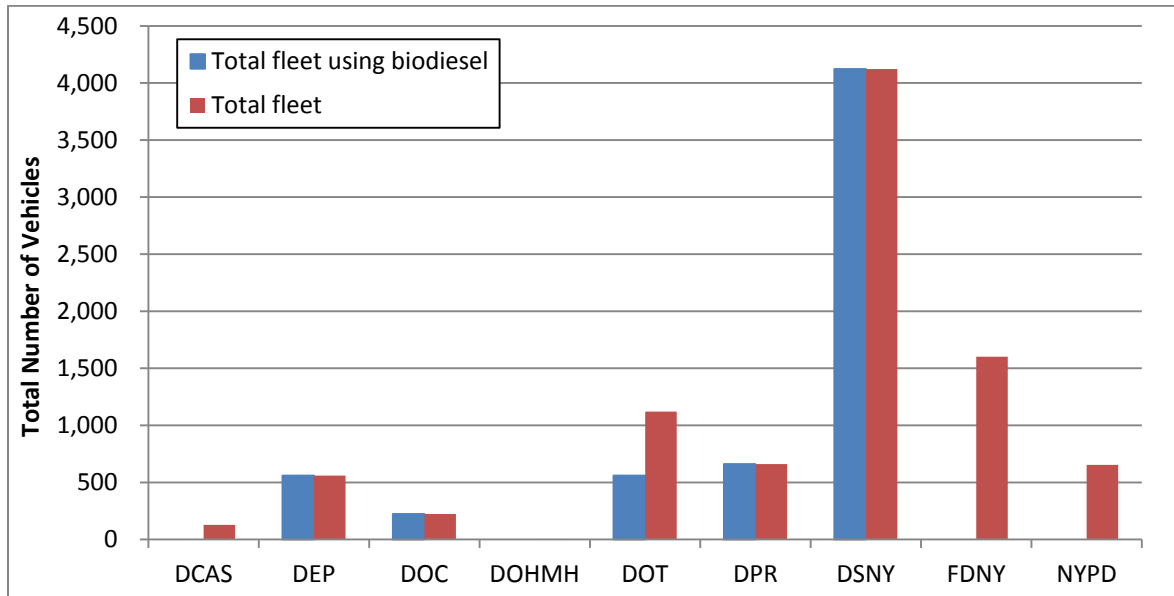
This breakout by agency is represented in the figure below. In 2012, out of nine agencies, four were not using biodiesel including the Department of Citywide Administrative Services, the Department of Health and Mental Hygiene, the New York City Fire Department, and the New York Police Department. It is expected that in 2013 all of the fleets will be using a minimum of B5 blend.

⁶⁵ City of New York, "PlanNYC," April 2011, pg. 125, accessed June 2013, http://nytelecom.vo.llnwd.net/o15/agencies/planyc2030/pdf/planyc_2011_planyc_full_report.pdf.

⁶⁶ Iowa Farmer Today, "Iowa Biodiesel Turning Heads in New York City," February 3, 2012, accessed June 2013, http://www.iowafarmertoday.com/news/regional/iowa-biodiesel-turning-heads-in-new-york-city/article_230b3fae-4dc7-11e1-8da3-001871e3ce6c.html.

⁶⁷ Department of Citywide Administrative Services, "NYC Fleet: Biodiesel Use in Fleets," PowerPoint Presentation, December 12, 2012.

Exhibit 11: Fleets Using Biodiesel Blends



Source: Department of Citywide Administrative Services, 2012.⁶⁸

The Department of Parks and Recreation and the Department of Sanitation led the way for other City agencies to implement biodiesel since 2005.⁶⁹ The Department of Parks and Recreation uses B20 in all of its diesel vehicles and equipment and has piloted B50 blends. Other agencies, including the departments of Sanitation, Transportation, and Environmental Protection, use B5 in their diesel fleets and switch to B20 during the summer.

The City is now moving to a biodiesel standard in two phases:

- Phase I (complete) – the use of B5 or greater for all non-emergency on-road units for the Department of Corrections on a year-round basis
- Phase II – 2013 – B5 for all units year-round and B20 for non-emergency on-road units during non-winter months (April through November)

In 2013 all of the fueling stations now dispense a minimum of a B5 fuel. Additionally, in order to reduce emissions the City has committed to expanding the use of biodiesel in the City’s fleet.⁷⁰ The city is now on track to use more than 5 million gallons of pure biodiesel in NYC fleet units in FY13 with a total of 70 percent of biodiesel blends in all diesel fuel consumed by the city as shown in the table below.⁷¹

Examples of these programs are highlighted in the following sections.

⁶⁸ Department of Citywide Administrative Services, “NYC Fleet: Biodiesel Use in Fleets,” PowerPoint Presentation, December 12, 2012.

⁶⁹ Keith Kerman, City of New York Parks & Recreation, “Report on the Use of Biodiesel and Ultra Low Sulfur Diesel for Parks Diesel Trucks and Equipment Citywide,” June 19, 2007, p.10.

⁷⁰ City of New York, “PlanNYC,” April 2011, pg. 125, accessed June 2013, http://nytelecom.vo.llnwd.net/o15/agencies/planyc2030/pdf/planyc_2011_planyc_full_report.pdf.

⁷¹ Department of Citywide Administrative Services, “NYC Fleet: Biodiesel Use in Fleets,” PowerPoint Presentation, December 12, 2012.

Exhibit 12: NYC Total Biodiesel Consumption by Agency (in gallons), FY12-FY13

Agency	Biodiesel			Total Diesel			% Biodiesel		
	FY12	FY13TD	12/ 2012	FY12	FY13TD	12/2012	FY12	FY13TD	12/ 2012
Correction	47,857	115,934	9,256	294,183	115,934	9,256	16%	100%	100%
Environmental Protection	214,463	131,703	22,325	308,028	134,275	22,625	70%	98%	99%
Fire	0	0	0	3,231,986	1,474,011	181,109	0%	0%	0%
Parks	540,187	312,954	41,170	595,926	312,954	41,170	91%	100%	100%
Police	0	0	0	360,020	292,042	69,525	0%	0%	0%
Sanitation	7,989,001	4,151,491	699,634	8,628,557	4,160,794	706,036	93%	100%	99%
Transportation	466,634	255,778	39,973	1,273,454	614,546	88,624	37%	42%	45%
Citywide	9,258,142	4,967,860	812,358	14,692,154	7,104,556	1,118,345	63%	70%	73%

Source: Department of Citywide Administrative Services, 2012.⁷²

3.1.1 Sanitation Department

The Sanitation Department has the largest municipal refuse fleet in the country, with 4,000 diesel vehicles, including diesel garbage trucks, dump trucks, and salt spreaders.⁷³ In 2007, the Department began using B5 in approximately 40 vehicles, and after verifying the performance in the fuel, began to use B5 in the entire fleet. The department is running a B20 blend in one location and is using B20 between April 2013 and November 2013. In order to ensure all fuel meets spec requirements, the City requires as part of its procurement process that all fuels be from BQ-9000® certified facilities (defined later in the report) to ensure the producers or marketers comply with industry best practices. Currently, Sprague Energy supplies the department's fuel and is BQ-9000® certified. Sanitation also has an oil sampling program with a lab onsite to take random samples of fuel in order to ensure top quality. Recently, Sanitation has not found any issues with biodiesel fuel quality, including blend variation.⁷⁴

To date, Sanitation has not tested any equipment above B20 and has not experienced any problems. Initially, Sanitation fleet engine manufacturers, Cummins and Mac, expressed concern about maintaining vehicle warranties with B20 blends, but eventually agreed to warranty B20 as part of the five year engine warranty package.⁷⁵ Additionally, Sanitation stores 75 percent of their equipment indoors, but has not had any problems with B20 fuel used in outdoor equipment, despite initial concerns about gelling in cold weather. Currently, the building maintenance division is responsible for transitioning refueling locations and underground storage tanks (USTs) to use biodiesel blends. Facility operators use standard operating procedures for tank maintenance and prep has been minimal to date.⁷⁶

⁷² Department of Citywide Administrative Services, "NYC Fleet: Biodiesel Use in Fleets," PowerPoint Presentation, December 12, 2012. Fiscal year is from July through June.

⁷³ National Biodiesel Board, "New York City Sanitation Department," accessed June 2013, <http://www.biodiesel.org/using-biodiesel/market-segments/fleets>.

⁷⁴ Interview with Rocky DiRico, Sanitation Department, April 1, 2013.

⁷⁵ Interview with Rocky DiRico, Sanitation Department, April 1, 2013.

⁷⁶ Interview with Rocky DiRico, Sanitation Department, April 1, 2013.

3.1.2 Port Authority/JFK International Airport

The Port Authority relies on B20 year-round for diesel equipment ranging from airport shuttles and buses to plows clearing snow for emergencies at JFK International Airport. The Port is considering increasing blends to B50 in the future.⁷⁷

Additionally, airlines are beginning to expand their biofuel consumption at JFK. In March 2013, KLM Royal Dutch Airlines launched a 25-week pilot program in partnership with the Port Authority of New York and New Jersey and others, to operate flights on biofuels between JFK and Schiphol Amsterdam Airport.⁷⁸

Under the pilot program, flights ran partially on sustainable kerosene derived from used cooking oil and blended into conventional jet fuel. SkyNRG, a company which KLM founded 2009 together with North Sea Group and Spring Associates, supplied the sustainable kerosene using Roundtable on Sustainable Biofuels certified biofuel. The Port Authority partnered with KLM and provided on-the ground facilitation and in-kind contributions of fueling services. The Port Authority also dedicated two 10,000-gallon refuelers to the operation.⁷⁹

3.1.3 New York Department of Transportation (DOT)

In the past, DOT used B5 in all its on-road equipment, but beginning in April 2013, DOT began operating solely on B20, with the exception of some pieces of some highly-specialized off-road equipment. These pieces of equipment are currently being verified for biodiesel compatibility with the OEMs. This is a potential issue for DOT as the agency fuels the off-road vehicles with mobile trucks and therefore may impact a larger number of total units.⁸⁰

In 2006, DOT had issues with B5 demonstrated in the Staten Island Ferry. It is believed that the barge fuel delivery wasn't properly blended, created separation issues in the fuel injectors ultimately clogging the fuel lines and leaving the ferry stranded in the harbor. As a result of this incident, the ferries no longer use biodiesel. DOT representatives now believe due to the increase in biodiesel supply around the harbor there may be more options for the ferry fleet.⁸¹ If the Staten Island Ferry's eight vessels were to use B5 again it could displace approximately 170,000 gallons of diesel annually.⁸²

⁷⁷ Iowa Soybean Review, "NYC Depends on Renewable Fuel Throughout the Year," March 1, 2012, accessed June 2013, <http://soybeanreview.com/article/big-city-emergencies-prove-no-problem-biodiesel-0>.

⁷⁸ Port Authority of New York and New Jersey, "Press Release: New York and Amsterdam Unite to Launch a New Era in Sustainable Aviation Initiate First-ever Series of Intercontinental Biofuel Flights," March 13, 2013, accessed June 2013, http://www.panynj.gov/press-room/press-item.cfm?headLine_id=1763.

⁷⁹ Port Authority of New York and New Jersey, "Press Release: New York and Amsterdam Unite to Launch a New Era in Sustainable Aviation Initiate First-ever Series of Intercontinental Biofuel Flights," March 13, 2013, accessed June 2013, http://www.panynj.gov/press-room/press-item.cfm?headLine_id=1763.

⁸⁰ Interview with Keith Kerman, Department of City Administrative Services, April 1, 2013.

⁸¹ Interview with Mark Simon, NYC Department of Transportation, April 3, 2013.

⁸² Based on 2009 consumption of 3,380,000 gallons of diesel. Biodiesel Magazine, "Metro to supply biodiesel for New York's 2nd Annual "City of Water Day," June 9, 2009, accessed June 2013, <http://www.biodieselmagazine.com/articles/3588/metro-to-supply-biodiesel-for-new-yorks-2nd-annual-city-of-water-day/>.

3.1.4 New York City B2 Heating Oil Mandate

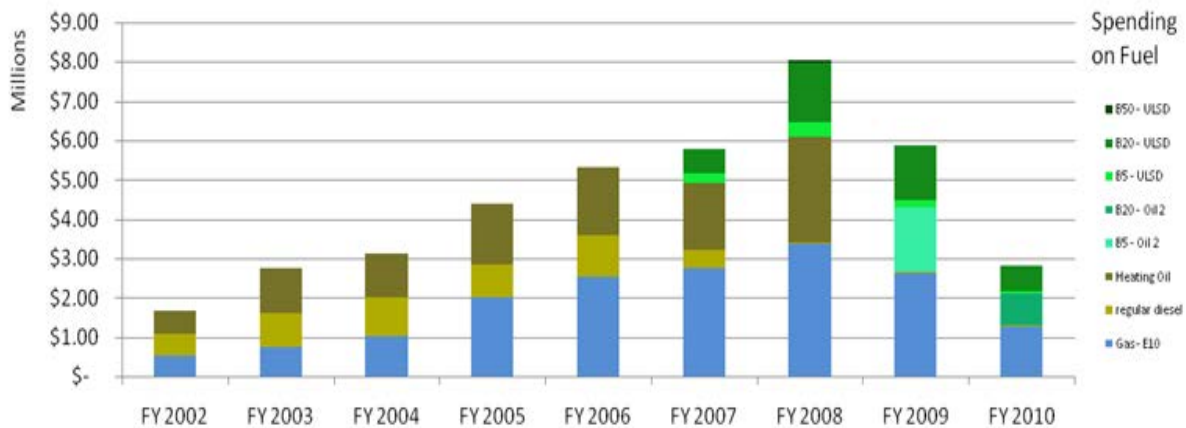
One of the most important programs is the Clean Heat program, which requires heating oil to be comprised of 2 percent or more of biodiesel, and went into effect October 2012. This bioheat mandate is a major driver for biodiesel consumption in the City. However the City’s B2 heating oil mandate currently excludes by definition biomass-based diesel fuels from renewable and cellulosic feedstocks as they do not comply with ASTM D6751 specifications.

3.2 Success Stories

3.2.1 Department of Parks and Recreation

Parks and Recreation operates over 850 heavy and medium duty vehicles and other equipment units that use diesel fuel. The agency has piloted the use of everything from B5 to B100 in equipment in engines ranging from 3 cylinder engines to V8 diesel, and 6 cylinder turbodiesels.⁸³ The equipment ranges in age with the oldest units well over 30 years and include over 46 types of units from 57 different manufacturers including dump trucks, packers, air compressors, backhoes, ballfield rakes, beach tractors, boom trucks, buses, carts, chippers, dredgers, extractors, forklifts, generators, leaf vacuums, light towers, mini-packers, pick-ups, stump cutters, sprayers, sweepers, tractors, trailers, tree trimmers, vans, water trucks and wreckers.⁸⁴ In FY06, Parks and Recreation dispensed 561,700 gallons of diesel fuel at a cost of \$1.24 million – an average cost of \$2.20/gallon – used at 10 different fueling locations.⁸⁵ Since then, Parks and Recreation has used an increasing amount of biodiesel and a successively lower price since its peak in FY08 as shown in Exhibit 13 below – one of the benefits of biodiesel.

Exhibit 13: Department of Parks and Recreation portion of fuel budget spent on biodiesel blends, heating oil, regular diesel, and gasoline (E10) between FY2002 and FY2010 (FY2010)



Source: Parks and Recreation, 2010.⁸⁶

⁸³ Keith Kerman, City of New York Parks & Recreation, “Report on the Use of Biodiesel and Ultra Low Sulfur Diesel for Parks Diesel Trucks and Equipment Citywide,” June 19, 2007, p. 2.

⁸⁴ Keith Kerman, City of New York Parks & Recreation, “Report on the Use of Biodiesel and Ultra Low Sulfur Diesel for Parks Diesel Trucks and Equipment Citywide,” June 19, 2007, pp. 2-6.

⁸⁵ Keith Kerman, City of New York Parks & Recreation, “Report on the Use of Biodiesel and Ultra Low Sulfur Diesel for Parks Diesel Trucks and Equipment Citywide,” June 19, 2007, p. 6.

⁸⁶ NYC Parks & Recreation, “Greening the Parks Fleet,” PowerPoint Presentation, April 22, 2010.

In 2011, the agency was recognized for its progressive use of biodiesel by the National Biodiesel Board. As of 2011, the agency used over 4.5 million gallons of biodiesel and spent over \$12 million on the fuel.⁸⁷ All 850 diesel fleet and equipment units at Parks use B20, with a successful B50 pilot project at Orchard Beach in the Bronx and the entire Staten Island diesel fleet. Ford has approved the use of B20 in its F-Series trucks and that could help expand biodiesel consumption in the fleet.⁸⁸

Parks and Recreation also uses bioheat in all of its 153 buildings. A total of 182 heating oil tanks have burned heating oil blends of B5 to B20 since 2007. Parks and Recreation uses on-road biodiesel supplied by Sprague Energy and bioheat from Metro Fuels.⁸⁹

The agency has had a few reported incidents since using the fuel in 2005. These include an issue in 2006 due to stalling due to the gelling of fuel during cold weather. The report impacted four vehicles in the Bronx when the temperature was 9° F. The vehicles were warmed up in the garage and only had a delay of about an hour. Since then there have been no other reported problems, and Parks and Recreation is uncertain whether the issue was related to B20 or potentially caused by an unrelated instance of water getting into the fuel dispensing tank.⁹⁰ Additionally, there was an issue with biodiesel in generators used at the World's Fair Marina when they were operating 24 hours daily due to electrical issues on-site. It was unclear if the issue was with the generators which were operating at a higher-than-normal capacity or if it was a fuel problem. Biodiesel use in some Gators required new filters as per manufacturer, which were replaced. There have also been fewer than ten cases where bioheat in extremely old facilities, such as historic houses (national or city registered landmarks) with extremely old boilers and lines caused clogged lines and solvency impacts. However, overall there has been a 95 percent success rate with B20. On the sites where they had issues, the repairs typically took less than one day and there were no long-term operational issues or high repair costs.⁹¹

⁸⁷ National Biodiesel Board, "New York City Sanitation Department," <http://www.biodiesel.org/using-biodiesel/market-segments/fleets>.

⁸⁸ Ford, "All-New Ford-Engineered, Ford-Test, Ford-Built Diesel Maximizes 2011 Super Duty's Productivity," August 31, 2009, http://media.ford.com/article_display.cfm?article_id=30879.

⁸⁹ Department of Parks and Recreation, "Parks Honored for Use of Biodiesel Technologies," The Daily Plant, Volume XXV, Number 5359, March 1, 2011, <http://www.nycgovparks.org/news/daily-plant?id=22368>.

⁹⁰ Keith Kerman, Department of Parks and Recreation, "Report on the Use of Biodiesel and Ultra Low Sulfur Diesel for Parks Diesel Trucks and Equipment Citywide," June 19, 2007, pp. 10-11.

⁹¹ Interview with Keith Kerman, Department of Citywide Administrative Services, April 1, 2013.

Exhibit 14: Biodiesel storage tanks used by the Department of Parks and Recreation at the onset of the biodiesel project



Source: Department of Citywide Administrative Services, 2012.⁹²

3.2.2 Biodiesel Support for Disaster Relief

During Hurricane Sandy relief efforts in October and November 2012, the City worked closely, 24 hours a day, with its fuel vendors to keep the City's 450 City owned fuel sites and 27,000 vehicles operating. The City used biodiesel blends throughout the storm response for the City's fleets with no reportable incidents.⁹³ Additionally, biodiesel distributors such as Tri-State Biodiesel, supplied biodiesel products to the Federal Emergency Management Agency and the National Guard for first responder and emergency service vehicles delivering food and emergency supplies in the Rockaways, Breezy Point, Red Hook, and Brooklyn areas. The biodiesel was also used to provide heat and power for the emergency camps built to house the out-of-town responders and to provide temporary shelter to those who were displaced by the storm.⁹⁴

3.2.3 Con Edison

In addition to biodiesel consumption among City fleets, other private fleets are also committing to use biodiesel in both on-road and off-road applications. In 2008, Con Edison, a subsidiary of Consolidated Edison, Inc., announced plans to use B20 in all of its 1,700 diesel trucks that at the time, would displace approximately 400,000 gallons of diesel annually.⁹⁵ In 2012, Con Edison consumed 308,000 gallons of

⁹² Department of Citywide Administrative Services, "NYC Fleet: Biodiesel Use in Fleets," PowerPoint Presentation, December 12, 2012.

⁹³ Department of Citywide Administrative Services, "NYC Fleet: Biodiesel Use in Fleets," PowerPoint Presentation, December 12, 2012 and interview with Keith Kerman, DCAS, April 1, 2013.

⁹⁴ Tri-State Biodiesel, "Tri-State Biodiesel supports recovery from Superstorm Sandy," Biodiesel Magazine, November 14, 2012, accessed June 2013, <http://www.biodieselmagazine.com/articles/8803/tri-state-biodiesel-supports-recovery-from-superstorm-sandy>.

⁹⁵ Consolidated Edison, "News Release: Con Edison Introduces a Greener Vehicle Fleet," June 24, 2008, accessed June 2013, <http://www.coned.com/newsroom/news/pr20080624.asp>.

B100.⁹⁶ As Con Edison is a transmission and distribution company, the company does not own electric generation plants and therefore has not used biodiesel for electricity generation.

3.2.4 NYC Biodiesel Procurement Requirements

In order to ensure the highest quality biodiesel fuel, the Department of Citywide Administrative Services (DCAS) developed procurement criteria for all vendors supplying the City (from 2011 through 2016 Castle has this contract). The specification describes the requirements of fuel oil blends containing B5 through B20 blends with ultra-low sulfur diesel fuel (specified as 1D or 2D Grade S15 and defined under the City of New York Specification 16-F-4:10A for diesel fuel oils). The biodiesel portion of the fuel must comply with ASTM D6751-09a (or the latest version) for B100 or ASTM D7467-09a for biodiesel blends between B6 to B20.⁹⁷ The City also requires that the blended fuel conform with existing U.S. Environmental Protection Agency (EPA) Provisions for Title II of the Clean Air Act, section 211, and regulations at 40 C.F.R. Parts 79 and 80 (or the latest version). The City also requires that the manufacturer, marketers or distributors of the B100 must be BQ-9000® certified and meet all the ASTM standards for the storage, sampling, testing, blending, shipping, distribution, and fuel management practices. All products using federally tax exempt fuel may be dyed red using solvent red dye 164 upon request.

An important aspect of the procurement requirement is the blend ratio of the biodiesel contained in any shipment of fuel. The finished fuel blend may only have +/- 2 percent of the requested blend specified in the purchase order.⁹⁸ For example, if the City were to order B5, the blend ratio must be within B4.9 to B5.1. This low tolerance for blend ratio may create problems for the fuel provider and terminals supplying the fuel at the rack, and necessitates the use of precise blending equipment, such as in-line blending. If the fuel is sampled and the blend ratio is deviated by 0.5 percent outside of the range, than the City will deduct 1 percent from the total cost of the delivered product.

Finally, the other significant difference from the City's procurement requirements is the maximum cloud point requirement for biodiesel. The cloud point of a fluid is the temperature at which dissolved solids are no longer completely soluble, precipitating as a second phase giving the fluid a cloudy appearance. This is particularly a problem in colder climates where low temperatures may increase the likelihood of solidifying waxes which can clogs fuel filters and injectors in engines. The maximum cloud point in the procurement requirements is defined by ASTM D975 - a diesel specification.⁹⁹

The cloud point is often directly connected to the type of feedstocks used in biodiesel production. Biodiesel produced from waste vegetable oils (yellow grease) and fats with higher free-fatty acid (FFA) content typically have a higher cloud point, which is why the majority of the biodiesel consumed in the City is made with virgin soy oils, which contain very low FFA content prior to the biodiesel production process.

⁹⁶ Based on email communication with Joseph Dente, Con Edison, June 21, 2013.

⁹⁷ Department of Citywide Administrative Services, Division of Municipal Supply Services, "Specification for Biodiesel B5 and B6 to B20 (on road use only)," Specification #16-F-5:10A, p. 1.

⁹⁸ Department of Citywide Administrative Services, Division of Municipal Supply Services, "Specification for Biodiesel B5 and B6 to B20 (on road use only)," Specification #16-F-5:10A, p. 2.

⁹⁹ Department of Citywide Administrative Services, Division of Municipal Supply Services, "Specification for Biodiesel B5 and B6 to B20 (on road use only)," Specification #16-F-5:10A, p. 3.

4 Supply, Consumption, & Infrastructure in NYC of Biomass-Based Diesel

4.1 Supply Chain

The supply chain of biodiesel for NYC begins with the processing of a variety of feedstocks discussed in Section 1 of this report into biodiesel. NYC has the infrastructure to receive produced biodiesel via trucks, barges, rail systems, and pipelines or to produce its own biodiesel, and then deliver it to distribution terminals. From the distribution terminals, biodiesel is blended with diesel fuel or home heating oil for end-use consumption.

NYC can obtain its biodiesel from in-state production, out-of-state supplies, and foreign imports. According to the National Biodiesel Board (NBB), as of 2012, NYS has three established biodiesel production facilities, in descending order of production capacity: Northern Biodiesel, Buffalo Biodiesel, and TMT Biofuels. In terms of out-of-state supplies, NYS receives its biodiesel from the Midwest and Gulf Coast regions. The biodiesel is then distributed to over 100 terminals throughout the greater NYC area for direct use or blending into B2, etc.

4.1.1 Production Capacity and Current Production of Biomass-Based Diesel

There is a significant lack of transparency around U.S. biodiesel production and consumption among biodiesel producers and data reporting agencies. The three sources for biodiesel data are Energy Information Administration (EIA - the statistical arm of the U.S. Department of Energy), the National Biodiesel Board (NBB - a national trade association), and the Biodiesel Magazine. However, the national level data from these sources for the last five years are not identical, leading to uncertainty regarding current production facility locations and fuel availability.

4.1.1.1 NBB and Biodiesel Magazine

For this report, data on individual plants was extracted and compiled using the NBB and the Biodiesel Magazine websites, both sources described in detail here. Most biodiesel companies in the U.S. are members of the NBB. The NBB website is frequently updated with information such as location, point of contact, production capacity, and type of feedstock. The Biodiesel Magazine's website shows a list of existing and under construction biodiesel production facilities. For each facility, the website includes information such as location, production capacity, and type of feedstock. The NBB and Biodiesel Magazine websites do not publish the actual production volumes or information about the current operational status of the production facilities. Additionally, some of the information is outdated and/or missing from the databases so research was conducted by exploring company websites and investor related material as well as phone interviews. Where better information was identified, it was used in this report. Finally, any inconsistencies in the databases such as the exclusion of a plant from the listing of nationwide biodiesel production plants on the NBB website (even if the plant is registered as an NBB member) or the inclusion of a plant that was recently completely shutdown were retained in this report.

Compiled individual plant data from NBB and Biodiesel Magazine indicates that in the PAD District (PADD) 1 (East Coast)¹⁰⁰, there are 67 biodiesel production facilities with a total annual production capacity of 362 million gallons, whereas, in PADD 2 (Midwest)¹⁰¹, there are 78 biodiesel production facilities with a total annual production capacity of approximately 1.1 billion gallons. Please note that this number of production facilities includes all facilities regardless of their current operational status (active or idle) based on market conditions or economics and may include any plants that were recently shutdown for which records have not been updated yet. Additionally, note that the average Midwest plant is more than twice as large as the plants on the East Coast.

Interviews with parties supplying biodiesel in the New York market indicate that regional production is used in meeting New York demands, but significant volume is transported from the Midwest and even the Gulf Coast. In the event biodiesel demands increase in the New York region through NYC initiatives, it appears additional supply could be secured from remote plants, as is currently done. However, it was also deemed prudent to examine the capacity of biodiesel plants in the Northeast corridor (Maine to Virginia) to assess their capacity to produce biodiesel to meet regional demands.

Focusing on production, Exhibit 15 below shows a compilation of all biodiesel production facilities that are on the NBB website or listed as existing plants on the Biodiesel Magazine website and their characteristics (city, state, annual production capacity, and type of feedstock, where available) in all states between Virginia and Maine. Please note that NBB data do not necessarily mean the listed plants are currently operational, but do represent a detailed account of known plants which could presumably be restarted if currently idle. Exhibit 16 below shows a list of biodiesel plants under construction in all states between Virginia and Maine.

Exhibit 15: Virginia to Maine Annual Production Capacity and type of feedstock for Biodiesel Production Facilities

City	Company	Production Capacity (MMgal/yr)	Type of Feedstock
Connecticut			
Bridgeport	Bridgeport Biodiesel, LLC	3.00	Multi feedstock
Southington	BioDiesel One Ltd	3.00	--
Bethlehem	Bio-Pur Inc.	0.8	Multi feedstock
Delaware			
Clayton	CGF Clayton LLC	11.00	Multi feedstock
Maine			
Portland	Maine Standard Biofuel	0.50	Multi feedstock
Maryland			
Adamstown	Chesapeake Green Fuels, LLC	1.00	Multi feedstock

¹⁰⁰ PAD Districts are a geographic aggregation of the 50 States and the District of Columbia into five Districts. PADD 1 is comprised of: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, Delaware, District of Columbia, Maryland, New Jersey, New York, Pennsylvania, Florida, Georgia, North Carolina, South Carolina, Virginia, and West Virginia, accessed June 2013, <http://www.eia.gov/oog/info/twip/padddef.html>.

¹⁰¹ PADD 2 is comprised of: Illinois, Indiana, Iowa, Kansas, Kentucky Michigan, Missouri, Nebraska, North Dakota, South Dakota, Ohio, Oklahoma, Tennessee, and Wisconsin, accessed June 2013, <http://www.eia.gov/oog/info/twip/padddef.html>.

City	Company	Production Capacity (MMgal/yr)	Type of Feedstock
Berlin	Maryland Biodiesel	1.00	Multi feedstock
Middle River	Petroless Fuel LLC	0.50	Multi feedstock
Princess Anne	Greenlight Biofuels LLC	0.00 ^b	Multi feedstock
Massachusetts			
Bridgewater	MPB Bioenergy LLC	0.50	Yellow Grease
Sandwich	Cape Cod BioFuels	0.50	Yellow Grease
Billerica	Baker Commodities Billerica		--
New Hampshire			
North Haverhill	White Mountain Biodiesel, LLC	5.50	Yellow Grease
Nashua	Batchelder Biodiesel Refineries	0.25	Yellow/Brown grease
Grafton	Outpost Biodiesel, LLC		Yellow Grease
New Jersey			
Elizabeth	Fuel: Bio One LLC	50.00	Yellow Grease/Animal Fats
Newark	Innovation Fuels Inc.	0.00 ^b	Multi feedstock
New York			
Ontario	Northern Biodiesel Inc.	20.00	Multi feedstock
Tonawanda	Buffalo Biodiesel	5.00	Yellow Grease
Port Leyden	TMT Biofuels, LLC	0.25	Yellow Grease
Pennsylvania			
Erie	HERO BX	45.00	Yellow Grease
Monaca	Pennsylvania Biodiesel Inc.	25.00	Multi feedstock
Camp Hill	Keystone BioFuels, Inc.	24.00	Multi feedstock
Pittsburgh	United Oil Company	15.00	Multi feedstock
Kane	Eagle BioDiesel Inc.	5.00	Multi feedstock
Middletown	Middletown Biofuels LLC	4.00	Soy Oil
Chester	Mother Earth Energy Inc.	3.00	Yellow Grease
Johnstown	US Alternative Fuels Corp.	2.10	Algae
Philadelphia	BlackGold Biofuels	0.26	Trap Grease/Wastewater Sludge
New Oxford	Soy Energy, Inc.	0.00 ^b	--
Erie	American Biodiesel Energy, Inc.		--
Rhode Island			
Westerly	Mason Biodiesel LLC	1.20	Multi feedstock
Newport	Newport Biodiesel, LLC	0.50	Yellow Grease
Virginia			
West Point	Virginia Biodiesel Refinery	7.00	Yellow Grease/Soy Oil

City	Company	Production Capacity (MMgal/yr)	Type of Feedstock
Richmond	RECO Biodiesel, LLC	5.00 ^b	Yellow Grease
Pennington Gap	Synergy Biofuels	3.00	Yellow Grease
Bassett	Red Birch Energy, Inc.	2.50	Multi feedstock
Clearbook	Shenandoah Agricultural Products	0.30	Yellow Grease
West Virginia			
Nitro	AC&S Inc.	3.00	Soy Oil
Virginia to Maine Total			
Total		247.35	

^a Multi feedstock refers to any combination of yellow/brown grease, animal fats, algae, and soy oil.

^b These production capacities were updated based on phone interviews.

Source: National Biodiesel Board, 2013; Biodiesel Magazine, 2013; company websites, 2013.

Exhibit 16: Virginia to Maine Under construction Biodiesel Production Facilities

City	Company	Production Capacity (MMgal/yr)	Type of Feedstock
Connecticut			
New Haven	Greenleaf Biofuels LLC	10.00	Yellow Grease
Massachusetts			
3Greenfield	Northeast Biodiesel LLC	3.50	Yellow Grease
New York			
Brooklyn	United Metro Energy Corp. (United Biofuels, Inc.)	50.00	Multi feedstock
Pennsylvania			
New Oxford	Soy Energy Inc.	2.50	Multi feedstock
Virginia to Maine Total			
Total		66.00	

* Multi feedstock refers to any combination of yellow/brown grease, animal fats, algae, and soy oil.

Source: Biodiesel Magazine, 2013; ICF International, 2013; “Catsimatidis inks deal to make United Metro Energy Corp. the largest heating oil and motor fuels distributor in the New York City metropolitan area,” PR Newswire, May 5, 2014.

<http://www.prnewswire.com/news-releases/catsimatidis-inks-deal-to-make-united-metro-energy-corp-the-largest-heating-oil-and-motor-fuels-distributor-in-the-new-york-city-metropolitan-area-257932251.html>

4.1.1.2 Energy Information Administration Reporting

The Monthly Biodiesel Production Report published by EIA provides production, consumption, import/export, sales, and feedstock data for biodiesel operations in the U.S.¹⁰² The information is compiled using the data submitted by all entities producing biodiesel that meets ASTM D6751

¹⁰² All editions for the Monthly Biodiesel Production Report available at <http://www.eia.gov/biofuels/biodiesel/production/>.

specifications and that is used for commercial purposes. This information is reported by producers in Form EIA-22M. “Monthly Biodiesel Production Survey”.¹⁰³ The individual plant data is aggregated and published in the report, which focuses on national and PADD level reporting.

Actual data on biodiesel production, import, and consumption values in individual States or in cities (for example, NYS or NYC) is not identified in the EIA reporting system and therefore, it is unclear how much production occurs by State. Since, EIA does not report biodiesel movements between PADDs (as it does for oil) it is impossible to bifurcate how much biodiesel is being supplied to NYC or even NYS from different PADDs or different States.

Although the annual production volumes are not available by state from Virginia to Maine, they are available at the larger PADD 1 level from EIA, from which an indicative regional utilization can be determined. It appears that active plants in the region are currently being significantly underutilized. This is evident from EIA’s monthly PADD 1¹⁰⁴ data showing 27 to 29 active production plants throughout 2012 resulting in annual production volume of 61 million gallons and a low production capacity utilization of 27 percent based on the EIA’s PADD 1 annual capacity of 224 million gallons.

NBB data shows a production capacity of 362 million gallons for PADD 1, and 247.5 million gallons for Maine to Virginia. EIA data shows a production capacity of 224 million gallons for PADD 1 and 131.0 million gallons for Maine to Virginia. From Maine to Virginia, according to monthly EIA data, there are 18 or 19 active biodiesel production facilities in 2012 with an annual production capacity of 131.0 million gallons. Additionally, in the same region, according to the NBB and the Biodiesel Magazine, there is a total 39 plants with an annual production capacity of 247.4 million gallons.

Assuming that the EIA production data fully reflects PADD 1 biodiesel production, the 61 million gallons produced would indicate a rough 27 percent utilization. While data does not exist to estimate utilization in the states from Maine to Virginia, it is likely utilization is in the 30 percent range (since these states have 60 percent of the EIA reported production capacity). If the NBB data includes additional operating plants, then the total utilization in PADD 1 would be even lower.

Regardless, the fact that even EIA data indicates that existing, operating plants in the Maine to Virginia region have –at a minimum - underutilized capacity of almost 70 million gallons of annual supply (131.0 million gallons capacity less 61 million gallons biodiesel production in ALL of PADD 1) demonstrates that NYC biodiesel growth initiatives are not encumbered by supply issues. As noted earlier, the completion and startup of the former Metro biodiesel facility by United Metro Energy will add significant city-based supply when completed in early 2014.

¹⁰³ Form EIA-22M – Monthly Biodiesel Production Survey, accessed March 2013, http://www.eia.gov/survey/form/eia_22m/proposed/form.pdf. Under Section 503 of the Energy Policy Act of 1992 and Section 1508 of the Energy Policy Act of 2005, all entities producing biodiesel, that meets ASTM D6751 specifications and that is used for commercial purposes are required to submit Form EIA-22M for each of their plants.

¹⁰⁴ PADD districts are a geographic aggregation of the 50 States and the District of Columbia into five Districts. PADD 1 is comprised of: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, Delaware, District of Columbia, Maryland, New Jersey, New York, Pennsylvania, Florida, Georgia, North Carolina, South Carolina, Virginia, and West Virginia.

4.1.1.3 Transport Methods

Once Biodiesel is produced at these production facilities, it can be transported using truck, rail, barge, or pipeline depending on the origin of facility, destination, infrastructure, distance, amount of biodiesel, and cost. In its most recent revised publication of *Biodiesel Handling and Use Guide*, NREL cites the properties of biodiesel that make it challenging to transport, regardless of mode of transportation.¹⁰⁵ Such properties include the Cold Filter Plugging Point (CFPP) which is defined as “the temperature at which a fuel will cause a fuel filter to plug due to fuel components, which have begun to crystallize or gel.”¹⁰⁶ For such circumstances of transporting biodiesel in cold weather, NREL provides acceptable temperature ranges along with the need for insulation for the railcar or truck. Additionally, NREL states the importance of proper inspection and washout of rail, truck, hoses, and seals to check for any incompatible residual. Finally, regardless of the mode of transportation, sampling and analyzing of the product must be conducted at each step to ensure the quality of biodiesel is not diminished.¹⁰⁷

In terms of volume, trucks can hold 6.6 to 7.2 thousand gallons of biodiesel, railcars can hold 23 to 26 thousand gallons of biodiesel, and individual barges can hold up to 400 thousand gallons of biodiesel.¹⁰⁸ The normal modes of biodiesel transport are by rail from major production regions (for example the Midwest) into distribution terminals, and from there by barge or truck into smaller terminals. Customers typically receive biodiesel blends by truck delivery from terminals. Additionally, the biodiesel industry has been testing transportation of biodiesel using pipeline since it believes that this option would be cheaper and more efficient. In 2009, Kinder Morgan was successful in commercially transporting biodiesel via its Plantation Pipeline System that runs approximately over 3,100 miles through the Southeastern states of the U.S.¹⁰⁹ (originating in Louisiana and ending in Washington DC). Kinder Morgan also expanded its commercial transportation of biodiesel via its 100-mile Oregon pipeline from Portland to Eugene.¹¹⁰ Movements by pipeline of renewable diesel or cellulosic diesel should not have quality issues since those fuels are hydrocarbon in nature.

Biodiesel and jet fuel are incompatible, and cross-contamination has been a threat for the aviation industry. The pipelines that regularly transport biodiesel, such as the Oregon pipeline can do so because such pipelines do not transport jet fuel therefore, eliminating the potential of contamination of any jet fuel batches.¹¹¹ Concerns with the above discussed properties of biodiesel (i.e. behavior of biodiesel at low temperatures), jet fuel specifications (allowing only 5 parts per million FAME), and lack of available quick testing methods has stalled the blending of biodiesel in jet fuel and the transportation of biodiesel via pipelines used for jet fuels. To decrease infrastructure compatibility issues and progress biodiesel blending, the National Advanced Biofuels Consortium (NABC), a Department of Energy (DOE)

¹⁰⁵ NREL, *Biodiesel Handling and Use Guide*, Fourth Edition (Revised), January 2009, accessed June 2013, <http://www.nrel.gov/vehiclesandfuels/pdfs/43672.pdf>.

¹⁰⁶ NBB, “Background,” accessed June 2013, http://www.biodiesel.org/docs/ffs-performace_usage/cold-flow-backgrounder.pdf?sfvrsn=4.

¹⁰⁷ Biodiesel Magazine, “Moving Biodiesel,” January 2008, accessed June 2013, <http://www.biodieselmagazine.com/articles/2049/moving-biodiesel>.

¹⁰⁸ Biodiesel Magazine, “Moving Biodiesel,” January 2008, accessed June 2013, <http://www.biodieselmagazine.com/articles/2049/moving-biodiesel>.

¹⁰⁹ Pipelines International, “Biodiesel via pipelines in US first,” July 2009, accessed June 2013, http://pipelinesinternational.com/news/biodiesel_via_pipelines_in_us_first/001583/

¹¹⁰ Kinder Morgan, “Products Pipeline,” accessed June 2013, http://www.kindermorgan.com/business/products_pipelines/.

¹¹¹ Pipeline and Gas Journal, “Kinder Morgan Begins Biodiesel Shipments on Oregon Pipeline,” Volume 236, No.9., September 2009, accessed June 2013, <http://www.pipelineandgasjournal.com/kinder-morgan-begins-biodiesel-shipments-oregon-pipeline>.

supported partnership of national laboratories, universities, and corporations, has been conducting research on the production of drop-in biofuels. The Alternative Data Fuels Center describes drop-in biofuels as hydrocarbon fuels that are similar in quality specifications to diesel, gasoline, and jet fuel and are therefore ready to "drop-in" to existing infrastructure.¹¹² New York in particular has interest in resolving the biodiesel and jet contamination issue in pipelines so that biodiesel blends can be shipped on the Buckeye system into Long Island as well as upstate New York.

4.1.1.4 U.S. Biodiesel Production Trend

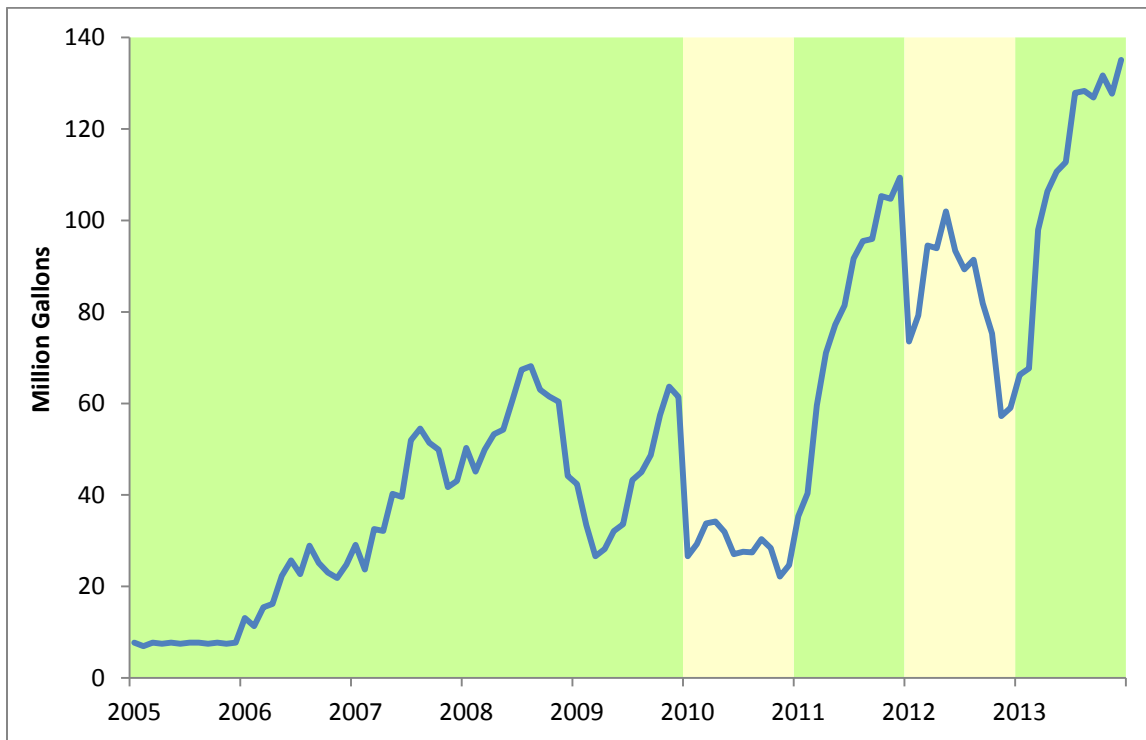
Incentive programs at the federal, state, and local levels throughout the country have encouraged biodiesel production. The Biodiesel Mixture Excise Tax Credit (BMETC), which provides a \$1 per gallon tax credit of pure biodiesel, agri-biodiesel, or renewable diesel blended with petroleum diesel to produce a mixture containing at least 0.1 percent diesel fuel, was introduced in 2005, expired at the end of 2009, but was reinstated in late 2010 through the end of 2011. Congress allowed the credit to expire again throughout 2012, but was retroactively reinstated in January 2013 to cover biodiesel blended from January 1, 2012 through December 31, 2013. Although the BMETC was not in effect during the entirety of 2005-2013, the retroactive nature of the subsequent federal legislation permitted all biodiesel blended between 2005 and 2013 meeting the requirements of the BMETC to be eligible for the tax credit at some point.

Exhibit 17 below shows a parallel effect on the monthly production of biodiesel in million gallons due to the different stages of the BMETC. The green shaded region in Exhibit 17 shows the presence of this tax credit while the yellow shaded region shows the time periods in which the tax credit was only available retroactively. Biodiesel production steadily increased from 2005 to 2008 from approximately 90 to 680 million gallons after the introduction of the tax credit. Production fluctuated between 2008 and 2010 declining to a noticeably low 340 million gallons in 2010 due to expiration of the tax credit and weak post-recession fuel demand. Production dramatically increased once the tax credit reinstatement was passed in late 2010 rising to approximately 970 million gallons in 2011. Production then dropped significantly at the start of 2012 when the tax credit expired. In January 2013, the BMETC was retroactively reinstated to cover biodiesel blended during 2012 and 2013. The dramatic increase at the end of 2013 was likely caused by producers rushing to gain the tax credit prior to expiration.¹¹³

¹¹² AFDC, "Drop-In Biofuels," accessed June 2013, http://www.afdc.energy.gov/fuels/emerging_dropin_biofuels.html.

¹¹³ EIA, "Monthly Energy Review," accessed March 2014, <http://www.eia.gov/totalenergy/data/monthly/index.cfm>.

Exhibit 17: U.S. Biodiesel Production Trend



Source: EIA, March 2014.

Note: the green shaded regions indicate the current existence of the BMETC; the yellow shaded regions indicate the retroactive existence of the BMETC.

4.1.2 Wholesale Supply

4.1.2.1 Terminal Operations and Quality Management

From the biodiesel processing plants, biodiesel is transported to distribution terminals by rail, truck or barge (limited volumes can move in pipelines as discussed earlier). The production is normally transported as either neat biodiesel (100 percent biodiesel), or is blended slightly (99.9 percent) by producers who wish to gain the Biodiesel Mixture Excise Tax Credit (BMETC) of \$1 per gallon credit for biodiesel blended with petroleum diesel. Once at the storage terminal, the biodiesel can be stored as neat or 99.9 percent biodiesel for sale as such. The biodiesel may also be blended with petroleum distillates and stored (B2 or B5 for example) or blended and loaded into trucks or barges for downstream distribution.

Terminals serve a variety of functions in the biodiesel supply chain. Large terminals can be distribution hubs that act as wholesale distribution centers to both receive and load biodiesel and petroleum products (i.e. gasoline, diesel, etc.) into delivery networks for intra- and inter-state movements. Delivery terminals are often more localized supply centers in which biodiesel products are lifted via a truck loading rack for delivery to nearby retail outlets and end-use consumers.

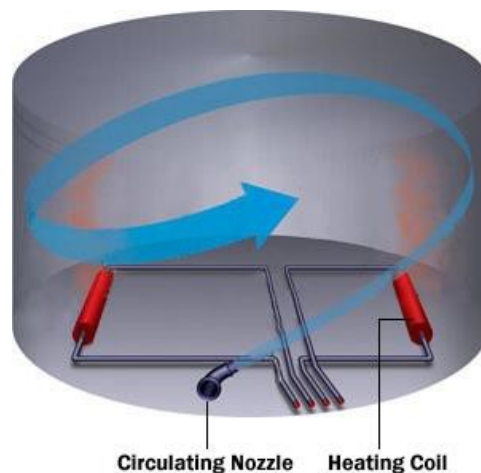
While terminals can load neat biodiesel, in many cases terminals provide a blended biodiesel product to distributors and end-users at levels such as B2, B5, and B20. There are several ways this blend can be

provided. In some cases, the terminal may mix a tank of fossil-based fuel with biodiesel to arrive at the desired blend; alternatively, a terminal may splash blend biodiesel into delivery trucks or barges to arrive at a desired blend.

However, the recommended technique is in-line blending to ensure the most accurate ratio of biodiesel blends. This system would pump the specified amounts of both fuels at high pressures and be electronically metered. This finished fuel would then be pumped into the delivery truck. However, this investment has to date only been made by about 100 terminals nationwide.¹¹⁴

As noted, biodiesel may also be blended using in-tank blending. As the term suggests, the two products are added into a storage tank, and heating coils and circulating nozzles mix the two products to create the finished blend as illustrated in Exhibit 18. Most tanks that are designed to store diesel can store B100. However, terminals are less likely to store neat biodiesel and are more likely to store lower blends of biodiesel. By doing so, terminals reduce investments such as displacing other products and addressing issues related to cold flow operability.

Exhibit 18: Illustration of In-Tank Blending with Heaters and Circulating Nozzle



Source: NBB, Paul Nazzaro, "Supply Chain Management", 2013.

The other frequently employed blending technique is known as splash blending. This involves loading both products into a delivery truck through separate lines at high enough fill rates to sufficiently blend the product. Further blending is possible from the stop-start action of the truck during delivery. If the fuel is inadequately mixed, serious consequences for end-use consumers' vehicles or other equipment is possible. Diesel engines that are not equipped to handle higher blends of biodiesel run the risk of plugged filters and degraded components such as hoses and seals.

Maintaining control of the biodiesel quality at terminals is a key issue. Since biodiesel is not corrosive like ethanol, biodiesel can be stored in any of the terminal's steel tanks. The tank should be drained of other products and cleaned before loading the biodiesel. If underground storage is available, then the constant underground temperature of about 50 degrees Fahrenheit would be above the biodiesel's cloud

¹¹⁴ Paul Nazzaro, "Supply Chain Management" presentation, NBB, 2013.

temperature and no heating is required.¹¹⁵ The cloud temperature is the point when solids are visible. Biodiesel typically has a cloud temperature that is higher than petroleum diesel’s cloud temperature. If the storage tank is above ground, then a heater is recommended but may not be necessary for tanks containing less than 5 percent biodiesel. It is recommended for a circulator to be installed in a storage tank containing higher biodiesel blends to promote homogeneity, especially if the blend has had no activity (no shipments out) in over 30 days.

Currently there are only six terminals in the NYC region that participate in the BQ-9000® program.¹¹⁶ They are listed in Exhibit 19. This program requires terminals to follow practices that assure the quality of the biodiesel by preventing nonconformity of blends and including processes for corrective action (this standard is discussed in greater detail in subsequent sections).

Exhibit 19: BQ9000 certified Terminals in NYC Area

Terminal	City	State
Castle Oil Corp Bronx	Bronx	NY
Castle Oil Corp Harrison	Harrison	NY
Hess Corporation Bronx Terminal	Bronx	NY
Hess Corporation Newark Terminal	Newark	NJ
United Metro Energy Corp.	Bronx	NY
Sprague Operating Resources Bronx	Bronx	NY

Source: BQ-9000® Quality Management Program, 2013.¹¹⁷

4.1.2.2 Terminal Storage Capacity for Biodiesel

Terminals typically do not store at capacity nor do they deplete their inventory. In the petroleum industry, a rule of thumb is that inventory is roughly about 40 percent full on average. This 40 percent is simply an average and will certainly fluctuate with inventory builds (adding product) and inventory draws (subtracting product) from storage. Immediately following a delivery of biodiesel into a terminal, volume stored will increase and then decrease over the coming days as biodiesel is outloaded into the market. This inflow and outflow is called “throughput” and can vary significantly between terminals depending on capacity, shipment volumes, and demand in the market.

The New York Department of Environmental Conservation (DEC) has divided the State into nine regions according to geography.¹¹⁸ Region 2 corresponds to the five NYC boroughs and Region 1 is Long Island. Both regions have significant biodiesel storage capacity that may be used to deploy biodiesel into the local market or transported elsewhere for consumption. According to data compiled by DEC,¹¹⁹ Region 1 has 21 tanks in 8 sites (this includes all active New York major facilities) with nearly 3.1 million gallons of tankage dedicated to biodiesel. Region 2 has 19 tanks in five sites with just over 2 million addition gallons of storage. Region 3 has no recorded biodiesel storage tanks.

¹¹⁵ NREL, Biodiesel Handling and Use Guide, Fourth Edition (Revised), January 2009, p. 22, accessed June 2013, <http://www.nrel.gov/vehiclesandfuels/pdfs/43672.pdf>.

¹¹⁶ BQ-9000®, “BQ-9000® Marketers,” accessed June 2013, <http://www.bq-9000.org/companies/marketers.aspx>.

¹¹⁷ BQ-9000®, “BQ-9000® Marketers,” accessed June 2013, <http://www.bq-9000.org/companies/marketers.aspx>.

¹¹⁸ Department of Environmental Conservation, “Regions,” accessed June 2013, <http://www.dec.ny.gov/about/50230.html>.

¹¹⁹ NYS Department of Environmental Conservation, “Major Oil Storage Facility Program,” updated May 16, 2013.

In addition to capacity that resides in the NYC portion of New York Harbor (NYH), significant storage exists on the New Jersey side. Northern New Jersey is integral to supplying NYC and other regions in the Mid-Atlantic with petroleum products and biofuels including biodiesel. However, there is no data which indicates the volume of biodiesel sourced in New Jersey that supplies terminals or end-users in New York.

Terminals in other regions of NYS like Nassau County sell biodiesel to NYC as well, but it is unclear if they will install additional equipment as they have a customer base outside of the mandated B2 NYC. Terminals that do not rely on the NYC market for a significant amount of their business may wait to see what issues early adopting terminals encounter before they themselves invest in equipment and resources.¹²⁰ Westchester and Suffolk Counties are expected to pass legislation similar to NYC's B2 mandate, and NYS has also discussed the possibility of implementing a B2 mandate statewide.¹²¹ Moreover, regional states like Connecticut have discussed implementing a bioheat mandate, but nothing formal has been approved.¹²² If other markets within New England and the Mid-Atlantic do pass mandates on bioheat that may spur biodiesel infrastructure development in the greater NYC area. Including Long Island and the Lower Hudson Valley would increase biodiesel tankage by approximately 5 million gallons at 33 storage sites.¹²³ Exhibit 20 shows the main biodiesel terminals in NYS. Most are concentrated primarily around the NYC region. (Note: this list may not be complete as some terminals do not identify biodiesel capacity in publicly available data sources.)

Exhibit 20: List of NYS Terminals with Biodiesel Capacity

Company Name	Location	Rail Supply	Biodiesel Tank Capacity (bbl)	Marine Access
Burt's Reliable, Inc.	Southold			
Castle Oil Corp.	Bronx			Yes
Castle Oil Corp.	Harrison			Yes
Hess Corp.	Bronx	Yes	--	Yes
John Ray & Sons	Troy			
Mirabito Fuel Group	Oneonta			
New Hyde Park Oil Terminal	New Hyde Park	Yes (New York & Atlantic Freight Co.)	Underground (976) + Above ground (6 cars of 595 bbl/car)	No
Schildwachter & Sons Oil	Bronx	No	12,000	Yes
Sprague Energy Corp.	Oceanside			
Sprague Energy Corp.	Rensselaer	No		Yes
Suma Energy, LLC	NYS			

¹²⁰ Interview with Cliff Hochhauser, Carbo Oil Terminal, 2013.

¹²¹ New York State Legislature, "Bill S1184-2013," accessed March 2013, <http://open.nysenate.gov/legislation/bill/S1184-2013>; Interview with Cliff Hochhauser, Carbo Oil Terminal, 2013; Interview with Steve Howell, Don Scott, Paul Nazarro, Shelby Neal, and Ray Albrecht, National Biodiesel Board, 2013.

¹²² Energy Communications Council, "CT Legislature Approves Energy Bills that Include Heating Oil Low-Sulfur and Biodiesel Mandates, Incentives for Efficient Equipment," May 10, 2010, accessed June 2013, <http://www.heatingnews.org/heatingoilnews.php?IID=7>.

¹²³ New York Department of Environmental Conservation Terminal Capacity Database.

Company Name	Location	Rail Supply	Biodiesel Tank Capacity (bbl)	Marine Access
TMT Biofuels LLC	Port Leyden		6,000	
Tri-State Biodiesel	Bronx			
United Metro Energy Corp.	Brooklyn			
United Metro Energy Corp.	Calverton			

Source: New York State Department of Environmental Conservation, 2013.; “DEC Regional Capacity Database, 2013.”; Other industry sources, 2013.

Terminal Delivery Capability

Limited data is available on the total biodiesel volumes moving into the NYC region and improving data sources would be helpful in assessing supply deliverability as additional biodiesel demand is added to the market. Based on discussions with industry experts in the greater NYC area, the consensus is that terminals have generally not had a problem complying with the B2 bioheat mandate. In addition, stakeholders do not believe the terminal infrastructure would have any problem dealing with a B5 blend in heating fuels or diesel. The bioheat mandate went into effect in October 2012, so experience with biodiesel is still in its early stages.

One hurdle that the B2 mandate faced in its first season was Hurricane Sandy. However, the City allowed a temporary waiver, so terminals who had difficulty receiving biodiesel due to the disruption could supply conventional heating oil without risk of penalties. That temporary measure was necessary as some terminals were non-operational and the few terminals that were operational did not have the ability to keep pace with biodiesel demand if the B2 mandate were in place. Hurricane Sandy also highlighted the importance of deliveries of biodiesel. Access to New York Harbor was restricted by the Coast Guard during Hurricane Sandy and terminals that relied on marine supply faced shortages.¹²⁴

4.2 U.S. Supply-Demand of Biomass-Based Diesel

4.2.1 Consumption

The United States is home to a number of biodiesel production plants that process various feedstocks into biodiesel. After production, biodiesel is supplied downstream via various modes of transportation and distribution to end-use consumers. Biodiesel is typically not consumed in its pure form (100 percent), but rather is blended with petroleum diesel to formulate various blends that are then consumed by end-users. Depending on how the supply chain is arranged and other factors such as RFS2 compliance, biodiesel and petroleum diesel can be and are blended at various stages in the supply chain. In some cases, petroleum refiners (obligated parties under RFS2) may purchase biodiesel and blend the fuels at terminals or refinery loading racks to produce the desired biodiesel blend (and subsequently store the blends in dedicated storage tanks). In other cases, biodiesel and petroleum diesel may not be blended until they are

¹²⁴ NYC Environmental Protection, “Department of Environmental Protection Announces Temporary Waiver of Two Percent Biodiesel Requirement for Heating Oil and New Streamlined Emergency Boiler Work Permit Guidelines to Aid Building Owners Recovering from Hurricane Sandy,” November 2, 2012, accessed June 2013, http://www.nyc.gov/html/dep/html/press_releases/12-83pr.shtml.

loaded into delivery trucks at refinery or terminal (downstream of petroleum refineries) loading racks for distribution to retail outlets.

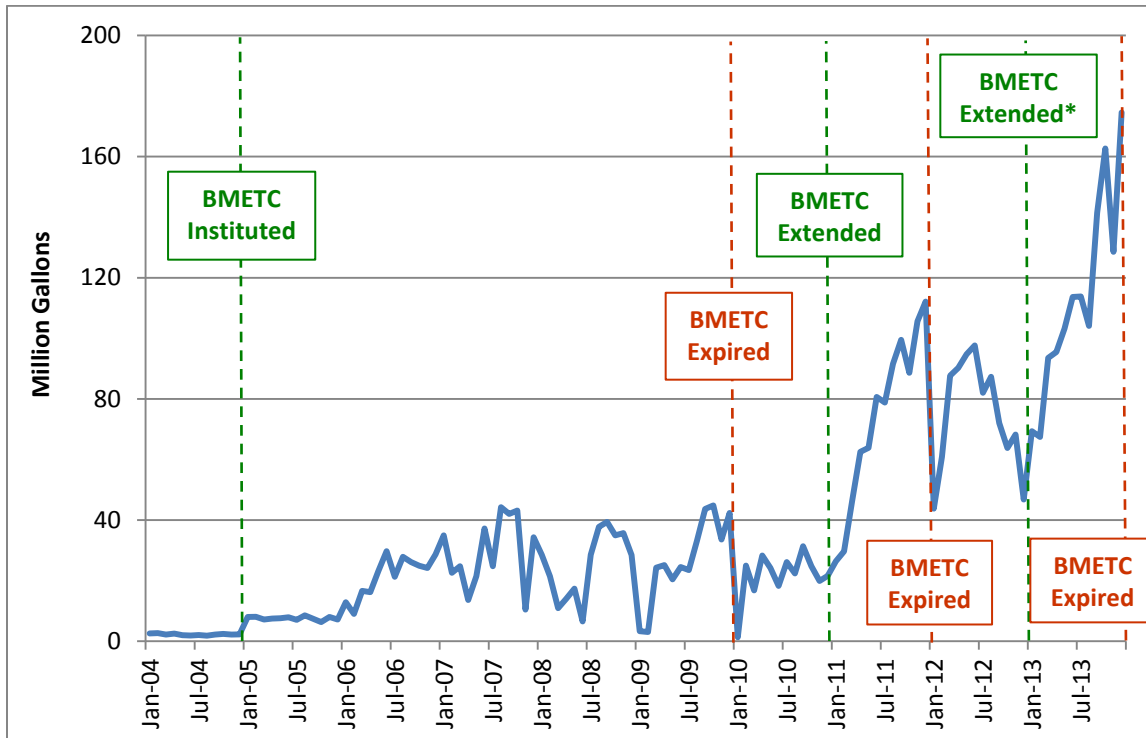
In the downstream market, the various biodiesel blends are consumed for on-road (e.g. trucks) and off-road (e.g. industrial boilers) purposes, including home heating oil. The deployment of biodiesel into the market has largely been driven by the RFS2, although better economics within the industry in recent years (due to the producer tax credit restoration) has helped biodiesel producers bring fuel to market at more competitive prices.

Exhibit 21 below shows monthly U.S. biodiesel (B100) consumption from 2004 through 2012. Since 2005, biodiesel consumption has rapidly increased, though with great volatility. Incentive programs at the federal, state, and local levels throughout the country have spurred the development and deployment of biodiesel production, transportation, and distribution infrastructure, which have driven the supply side of the biodiesel equation while other incentives have targeted consumers to spur the demand side. The jump in biodiesel consumption in January 2005 corresponds to the institution of the Biodiesel Mixture Excise Tax Credit (BMETC). The BMETC (discussed earlier in Section 4.1.1.4) provides a \$1 per gallon tax credit of pure biodiesel, agri-biodiesel, or renewable diesel blended with petroleum diesel to produce a mixture containing at least 0.1 percent diesel fuel. This tax credit expired December 31, 2009, which coincides with a large drop in biodiesel consumption in January 2010. At the end of 2010, the tax credit was extended through December 31, 2011 which prompted a large resurgence in biodiesel consumption through 2011, and the year-end expiration led to the massive drop in consumption in January 2012.¹²⁵ The BMETC was then retroactively reinstated in January 2013 to cover biodiesel blended from January 1, 2012 through December 31, 2013 and may have driven increased consumption during the year.¹²⁶

The primary factors driving biodiesel consumption appear to be the obligations under RFS2 for refiners and importers, and the price of biodiesel compared to petroleum based diesel. The availability of the BMETC provides a significant benefit to the price equation, encouraging the trends seen in Exhibit 21.

¹²⁵ AFDC, "Biodiesel Mixture Excise Tax Credit," accessed June 2013, <http://www.afdc.energy.gov/laws/law/US/395>.

¹²⁶ "American Taxpayer Relief Act of 2012," Public Law 112-240, 112th Congress, January 2, 2013, accessed April 2014, <http://www.gpo.gov/fdsys/pkg/PLAW-112publ240/pdf/PLAW-112publ240.pdf>

Exhibit 21: U.S. Monthly Biodiesel (B100) Consumption


Source: EIA, 2014.¹²⁷

*The BMETC was retroactively reinstated in January 2013 to cover biodiesel blended from January 1, 2012 through December 31, 2013.

4.2.2 Imports-Exports of Biomass-Based Diesel

In addition to domestic production and consumption, biodiesel is also traded on the international market. Like other industries, imports and exports are driven largely by global market prices, and domestic and foreign trade regulations. Similar to petroleum products, biodiesel is shipped internationally on large ocean-going vessels that can transport millions of gallons of biodiesel. Unlike 2012 in which only six shipments of biodiesel originated outside Canada, 92 cargoes larger than 500 barrels (21,000 gallons) arrived in 2013 from countries in South America, Europe, and Asia.¹²⁸ Transporting biodiesel on such a large scale helps reduce average costs per gallon, which makes long-distance trade a relatively small component of delivered fuel costs. Thus, barring trade limitations like tariffs and quotas, imports and exports of biodiesel will be largely determined by relative pricing in different markets, economic incentives (i.e. tax incentives), and the cost of shipping the biodiesel to the most attractive market.

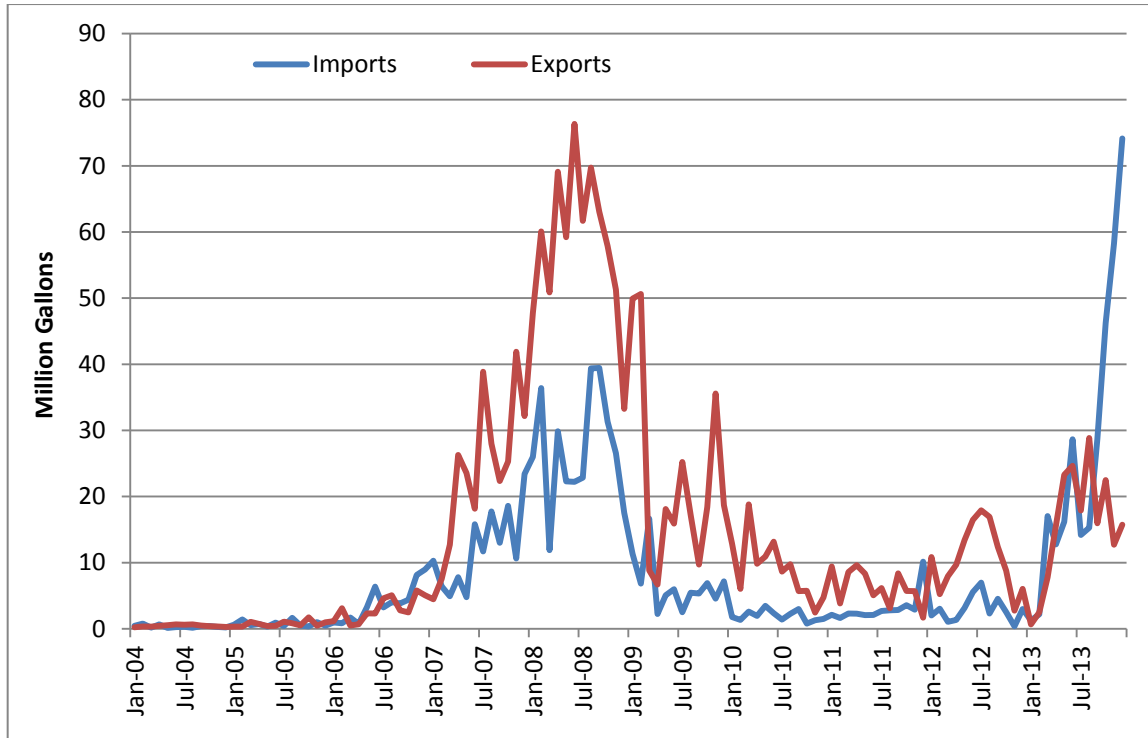
Exhibit 22 shows the monthly U.S. biodiesel trade since 2004. As seen in the exhibit, the U.S. has primarily been a net exporter of biodiesel over the last decade, with exports peaking in June 2008 at over 75 million gallons (54 million gallons of net exports). This trend has slowed since 2008 and reversed in

¹²⁷ EIA, "Monthly Energy Review," accessed March 2014, <http://www.eia.gov/totalenergy/data/monthly/index.cfm>.

¹²⁸ EIA, "Company Level Imports," accessed March 2014, <http://www.eia.gov/petroleum/imports/companylevel/>

2013. The U.S. became a large net *importer* of biodiesel at the end of 2013 when exports remained relatively steady and imports increased rapidly to reach 74 million gallons in December 2013.¹²⁹

Exhibit 22: U.S. Monthly Biodiesel (B100) International Trade Balance



Source: EIA, 2014.¹³⁰

The boom in U.S. international trade of biodiesel in 2007 and 2008 was largely driven by a tax arbitrage opportunity in the U.S. and the European Union (EU). In the U.S., companies received a \$1 per gallon tax credit for each gallon of biodiesel blended with petroleum diesel under the BMETC regardless of where the biodiesel was sourced – produced domestically or imported from abroad. Firms would blend biodiesel with the minimum amount of petroleum diesel (0.1 percent diesel with 99.9 percent biodiesel) to earn the tax credit. Then, the slightly blended fuel was exported to the EU where the fuel received additional tax credits. As this money-making opportunity was deployed by firms involved in the biodiesel trade, the additional biodiesel supply to the U.S. was imported rather than purchased from domestic producers, which is shown by the corresponding surge in biodiesel imports in Exhibit 22 above. In October 2008, this loophole was closed when the eligibility for the BMETC was rendered not applicable for biodiesel that was produced outside the U.S. *and* consumed outside the U.S. At the time, 90 percent of the biodiesel imported into the EU came from the U.S., which prompted the EU to institute biodiesel trade restrictions to also combat this tax loophole.¹³¹

¹²⁹ EIA, “Monthly Energy Review,” accessed March 2014, <http://www.eia.gov/totalenergy/data/monthly/index.cfm>.

¹³⁰ EIA, “Monthly Energy Review,” accessed March 2014, <http://www.eia.gov/totalenergy/data/monthly/index.cfm#renewable>.

¹³¹ U.S. Department of Agriculture, “The Renewable Identification Number System and U.S. Biofuel Mandates,” November 2011, <http://www.ers.usda.gov/media/138383/bio03.pdf>.

The escalation in biodiesel imports seen in the fourth quarter 2013 was driven by the imminent expiration of the BMETC. Market participants wanting to take advantage of the \$1 per gallon tax credit before it expired rushed to import biodiesel, setting imported volume records in October, November, and December 2013. Argentina was the main source of these imports (over 50 percent according to EIA¹³²) as biodiesel exports from Argentina to the EU had been curtailed due to anti-dumping regulations imposed by the European Commission in May 2013. However, with the expiration of the BMETC, no exports of biodiesel from Argentina to the U.S. was reported during the first five weeks of 2014.¹³³

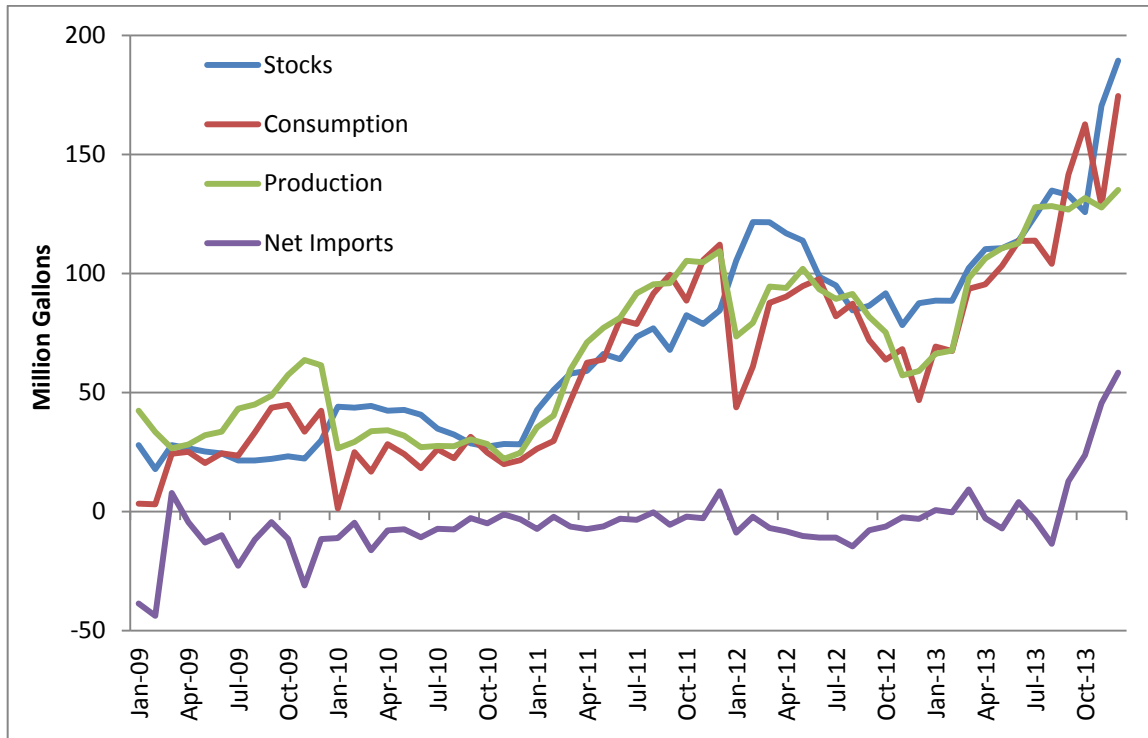
4.2.3 Storage of Biomass-Based Diesel

After production, biodiesel can be stored directly at production plants for sale into the market or delivered to terminals for temporary storage before the product is sent downstream to secondary storage facilities or end-use consumers. The storage piece of the supply chain is the final portion of the U.S. supply-demand balance for biodiesel. Exhibit 23 below shows monthly U.S. stocks, consumption, production, and net imports (imports minus exports) of biodiesel. As seen in Exhibit 23, net imports have remained relatively consistent over the period (as seen earlier where exports and imports followed one another), aside from the recent surge in net imports. Although production and consumption have tracked one another closely since 2009, separation between the two will lead to either: 1) inventory builds (when stocks increase) or inventory draws (when stocks decrease), or 2) changes in trade balance (i.e. net imports). These changes help balance the physical quantities of biodiesel available in the market.

¹³² EIA, "Company Level Imports," accessed March 2014, <http://www.eia.gov/petroleum/imports/companylevel/>

¹³³ Platts, "US Biodiesel Imports Post Fresh Record in Dec; Annual Total Soars," February 7, 2014, accessed April 2, 2014, <http://www.platts.com/latest-news/agriculture/montreal/us-biodiesel-imports-post-fresh-record-in-dec-21185642>

Exhibit 23: U.S. Monthly Biodiesel (B100) Supply-Demand



Source: EIA, 2014.¹³⁴

Note that when consumption dropped in early 2012 with the loss of the BMETC, inventory built in the U.S. system, and production declined rapidly at the same time. Also, when consumption and stocks increased while production remained flat at the end of 2013, the extra biodiesel supply was sourced from international markets as demonstrated by the rise in net imports. Overall, the linkage between demand and production is aligned well. This trend may indicate that the supply chain from producers to consumers is tight, meaning that as demand declines, producers who supply those demands reduce runs. This is different than what happens in U.S. petroleum refineries, where reductions in diesel sales may simply result in more spot market sales of diesel or export sales.

4.3 Biomass-Based Diesel Consumption in New York City

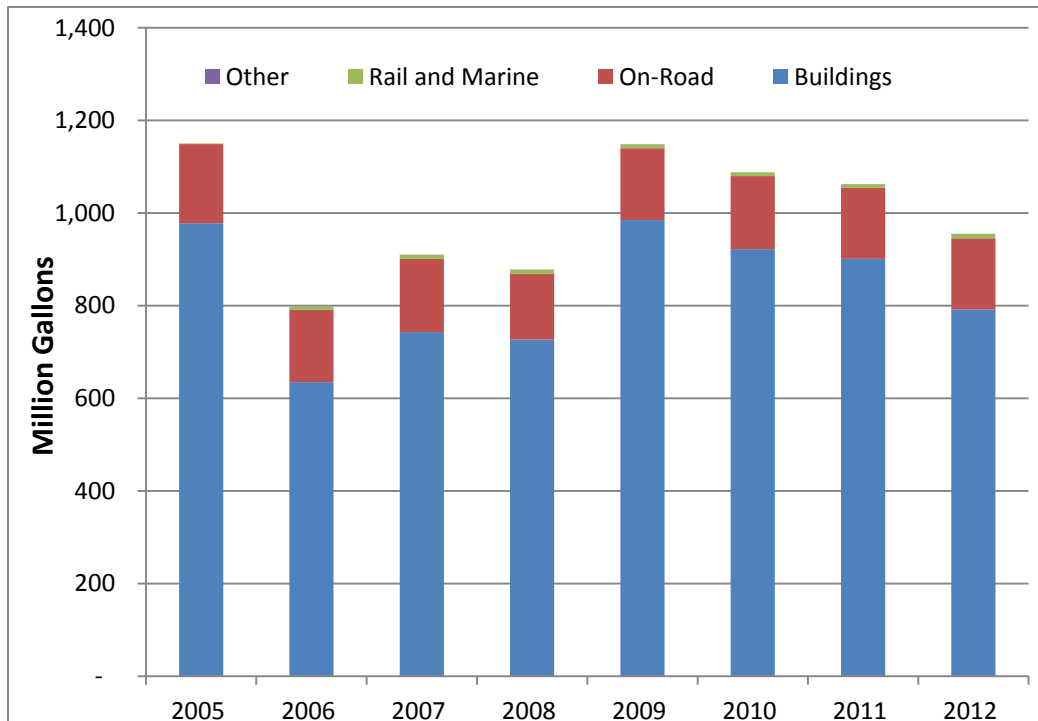
Due to limitations on data collection and accessibility, a variety of sources were used to assess the volume of biodiesel consumption in NYC. This section uses publicly available data of fuel oil consumption to create an estimate of biomass-based diesel consumption in addition to industry statements about biodiesel consumption in heating oil. While specific county-level demand is not available, a large portion of the State’s population resides in the downstate market (including NYC and Long Island), suggesting that a large proportion of total statewide heating oil demand is concentrated in this region as well. In short, the volumes developed are the best estimates available, but they are estimates.

¹³⁴ EIA, “Monthly Energy Review, accessed March 2014, <http://www.eia.gov/totalenergy/data/monthly/index.cfm#renewable>.

4.3.1 Fuel Oil Consumption in New York City

Petroleum-based fuel oil consumption (No. 1, No. 2, No. 4, and No. 6 fuel oils) in NYC ranged from about 800 to 1,150 million gallons between 2005 and 2012, averaging about 1 billion gallons per year. These estimates cover both private and public consumption, and consumption by both the on- and off-road markets. In 2012, fuel oil consumption was below average at about 955 million gallons. Exhibit 24 shows distillate consumption by end-use over this time period.¹³⁵

Exhibit 24: NYC Fuel Oil Consumption by End-Use



* Includes only petroleum, no biofuel

** 2012 building consumption of fuel oil was estimated due to large data discrepancies

Source: City of New York, 2013.¹³⁶

As seen in the figure above, the largest consumers of distillate in NYC are residential, commercial, and institutional buildings. Buildings consume No. 2, No. 4, and No. 6 fuel oils as well as negligible amounts of biodiesel and kerosene as a source of heating.¹³⁷ In 2012, according to PlaNYC, buildings in NYC consumed about 800 million gallons of fuel oil. Meanwhile, biodiesel only accounted for about 104,000 gallons.

The second largest consumer of diesel fuel in NYC was by on-road vehicles. The on-road sector is comprised of on-road vehicles that consume diesel fuel (a type of distillate fuel used by the transportation sector) such as trucks, buses, and cars. This sector consumed about 153 million gallons of distillate fuel in

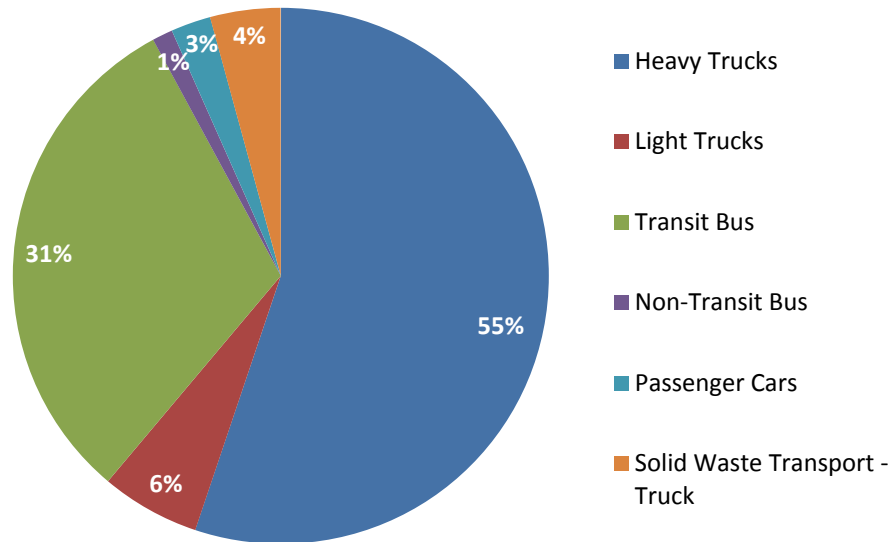
¹³⁵ City of New York, Inventory of New York City Greenhouse Gas Emissions, December 2013, by Jonathan Dickinson, et al. Mayor's Office of Long-Term Planning and Sustainability, New York, 2013. PlaNYC 2010, 2011, 2012.

¹³⁶ City of New York, Inventory of New York City Greenhouse Gas Emissions, December 2013, by Jonathan Dickinson, et al. Mayor's Office of Long-Term Planning and Sustainability, New York, 2013. PlaNYC 2010, 2011, and 2012.

¹³⁷ No. 2 fuel oil is a portion of the "distillate cut" from refining crude oil. It includes products like heating oil and on-road diesel fuel.

2012 (the same as 2011). Exhibit 25 below shows the consumption proportion by each vehicle class in 2012. The two largest users of diesel are heavy trucks and transit buses which accounted for 86 percent of on-road consumption. Heavy trucks include commercial vehicles such as delivery trucks, dump trucks, and refuse trucks. Transit buses include city buses operated by the Metropolitan Transportation Authority (MTA) and New Jersey Transit (NJT).

Exhibit 25: 2012 Highway Distillate Consumption



Source: City of New York, 2013.¹³⁸

4.3.2 Biodiesel Consumption in New York City

Biodiesel is largely entering the NYC market via two avenues. The Clean Heat program, discussed earlier in this report, requires heating oil to be comprised of 2 percent or more of biodiesel. This bioheat mandate is a major driver for biodiesel consumption in the City. In addition, biodiesel is also consumed by light-duty vehicles and heavy-duty trucks for on-road applications. Although there are some concerns with higher concentration fuels, most diesel vehicles are capable of consuming blends up to 20 percent biodiesel with little to no performance issues or equipment upgrades. The limiting factor in biodiesel’s use in the on-road market is largely impacted by supply distribution. Retail outlets supplying biodiesel blends above 5 percent are scarce in NYC (while blends below B5 can be sold as normal on-road diesel), so a large portion of the City’s consumption is driven by municipal and private fleets that have dedicated fueling outlets and are not available to the public.

The NY State Department of Taxation collects data on B20 consumption for on-road and off-road use in the entire State. In 2012, the Department of Taxation reported that 2.10 million gallons of B20 biodiesel consumed in NY State were for transportation and 0.92 million gallons were consumed in the off-road market. From 2007 through 2012, consumption volumes increased over three-fold and trended upward the entire time aside from a slight decline in 2010. However, the Department of Taxation data only covers

¹³⁸ City of New York, Inventory of New York City Greenhouse Gas Emissions, December 2013, by Jonathan Dickinson, et al. Mayor’s Office of Long-Term Planning and Sustainability, New York, 2013.

taxable gallons of blended fuel that are B20 and above. Consequently, it does not capture biodiesel that is consumed in lower blended fuel. Since these lower blends are widely consumed and the data does not cover consumption by tax-exempt entities like municipal fleets, these Department of Taxation volumes are clearly well below actual biodiesel consumption.

At the city level, data is available from the previously mentioned PlaNYC and from the Clean Cities Coalition. Clean Cities is a network of nearly 100 communities comprised of businesses, fuel providers, vehicle fleets, state and local government agencies, and community organizations. These stakeholders provide voluntary data to the local coalition, which in this case is the Empire Clean Cities Coalition. However, upon analysis, this data proved to be fairly volatile and not consistent. Moreover, it did not match with other information and understanding that ICF has regarding the distillate and biodiesel markets in NYC.

Exhibit 26 estimates annual biodiesel consumption in NYC. The top five rows of the table are consumption volumes described earlier in the report for City agencies. These volumes are for the Fiscal Year 2012, which ran from July 1, 2011 through June 30, 2012. The subsequent rows are estimates for annual biodiesel consumption in heating oil based on 2011 volumes from PlaNYC. These 2011 heating oil consumption volumes were converted to biodiesel estimates taking into account the 2 percent mandate and differences in heat content between biodiesel and the displaced fuels (No. 2, No. 4, and No. 6). These volumes are merely illustrative of approximate annual consumption volumes of biodiesel that will be consumed under the 2 percent mandate and do not reflect actual consumption.

Exhibit 26: Biodiesel Consumption Points in NYC

Thousand Gallons	FY 2012
Correction (NYC Agency)	48
Environmental Protection (NYC Agency)	214
Parks (NYC Agency)	540
Sanitation (NYC Agency)	7,989
Transportation (NYC Agency)	467
Biodiesel in No. 2 Heating*	12,300
Biodiesel in No. 4 Heating*	1,991
Biodiesel in No. 6 Heating*	5,741
Total	29,291

Source: City of New York, 2012; NYC Citywide Administrative Services, 2012.¹³⁹

* These volumes were calculated based on 2 percent of 2011 heating oil consumption converted to biodiesel volumes using BTU/gallon contents of: Biodiesel – 128,000; No. 2 – 138,690; No. 4 – 144,190; No. 6 – 149,690

According to interviews with stakeholders during the formulation of this report, it was widely held that about 1 billion gallons of heating oil is consumed each heating season. Some stakeholders estimated that 20 million gallons of biodiesel was consumed within this volume (2 percent), which was corroborated by

¹³⁹ City of New York, Inventory of New York City Greenhouse Gas Emissions, December 2012, by Jonathan Dickinson, et al. Mayor's Office of Long-Term Planning and Sustainability, New York, 2012; NYC Citywide Administrative Services, "NYC Fleet: Biodiesel Use in Fleets," PowerPoint Presentation, December 12, 2012.

the estimates in the table above. Meanwhile, other stakeholders maintained that more biodiesel was penetrating the heating oil pool above the 2 percent mandate due to more competitive biodiesel pricing, which were further aided by the reinstatement of the BMETC in January 2013. Heating oil may contain up to 5 percent biodiesel without having to be communicated to customers, thus these stakeholders believed that the 20 million gallon estimate is conservative.

In addition to data discrepancy concerns, it should be noted that this table does not include all avenues through which biodiesel may be consumed in the City such as public consumption for on-road purposes.

4.3.3 On-Road Fueling Station Infrastructure

In NYC, there are currently four on-road biodiesel fueling stations (three private, one public) that are dispensing biodiesel blends B20 and above.

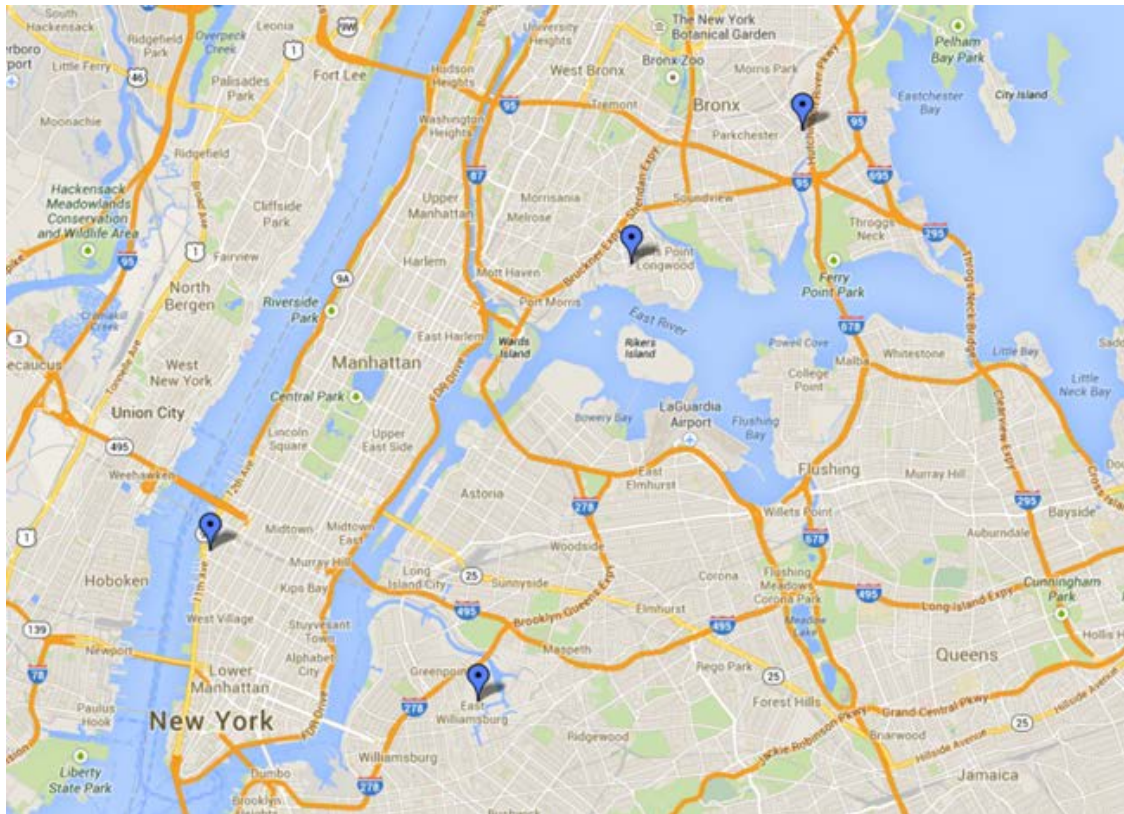
Exhibit 27: Biodiesel Fueling Sites in NYC with B20 and Above

Station Name	Biodiesel Blends	Street Address	City	ZIP	Station Phone	Access
US Postal Service - Manhattan Vehicle Maintenance Facility	B20	201 11th Ave	New York	10199		Private - government only
Schildwachter & Sons Oil	B20	1400 Ferris Pl	Bronx	10461	718-828-2500	Private - fleet customers only
Tri-State Biodiesel	B100, B99	531 Barretto St	Bronx	10474	718-860-6600	Public - see hours
National Grid	B20	287 Maspeth Ave	Greenpoint	11211		Private

Source: Alternative Fuels Data Center (AFDC) Station Locator, 2014.¹⁴⁰

¹⁴⁰ AFDC, "Alternative Fueling Station Locator", accessed March 2014, <http://www.afdc.energy.gov/locator/stations/>.

Exhibit 28: Map of Biodiesel Fueling Stations in NYC Dispensing B20 and Above



Source: AFDC¹⁴¹; Google Maps.

As of March 2014, there is no comprehensive resource that lists public and private biodiesel fueling stations carrying biodiesel blends below B20; however, it is known that the City of New York is operating approximately 450 private access biodiesel fueling stations that dispense blends below B20 to the fleet.¹⁴² As noted above in *Biomass-Based Diesel Programs in New York City*, the NYC fleet is required to fuel all on-road city vehicles with B5; however, some agency fleets employ biodiesel blends above B5 in the summer. As NYC sets further goals for implementing biodiesel in their fleets, stations may choose to dispense higher level biodiesel blends over time, including B20.

With regard to public access fueling stations in NYC, the amount and locations of stations selling biodiesel blends less than B20 is difficult to quantify, as blends up to B5 are not required to be labeled at the pump. Blends above B5 do require labels in NYS; however, information is not readily available on stations within NYC that are currently selling B5-B20 blends, nor on stations selling diesel fuel at biodiesel levels under 5 percent.

¹⁴¹ AFDC, "Alternative Fueling Station Locator", accessed March 2014, <http://www.afdc.energy.gov/locator/stations/>.

¹⁴² NYC Citywide Administrative Services, "NYC Fleet: Biodiesel Use in Fleets," PowerPoint Presentation, December 12, 2012; Interview with Keith Kerman, DCAS, April 1, 2013.

5 Economics and Incentives for Biomass-Based Diesel

5.1 Biomass-Based Diesel Market Landscape in NYC and NYS

Biodiesel has largely entered the fuels market in NYS and NYC through two avenues: heating oil and on-road consumption by diesel fueled vehicles. Pure or “neat” biodiesel is rarely consumed as is, but rather is used as a blending component with petroleum products like diesel fuel to formulate finished products. In NYC, mandates went into effect in October 2012 that require heating oil consumed in the City to be comprised of at least 2 percent biodiesel (B2). No similar mandate currently exists for the on-road market (outside of the blending requirements from RFS2, discussed later in this section); however, stakeholders widely believe that biodiesel is currently penetrating both the on-road market and the heating oil market beyond the 2 percent requirement, according to industry sources and corroborated by an article in the Platts *Oilgram Price Report*. The article sites large refiners such as Chevron, Shell, ExxonMobil, and Valero as selling biodiesel blends up to 5 percent through branded retail outlets.¹⁴³

The following section details the pricing of biodiesel and biodiesel blended fuels in various cities in and around New York State with a particular focus on NYC.

5.1.1 Price of Neat Biodiesel (B100)

Neat biodiesel is typically blended with petroleum diesel to produce a variety of fuel blends (e.g., B2, B5, and B20) that are then sold to downstream markets. Due to a lack of available B100 prices, B99 rack prices from the Oil Price Information Service (OPIS) are analyzed in this section to reflect the neat biodiesel price in the various markets.¹⁴⁴

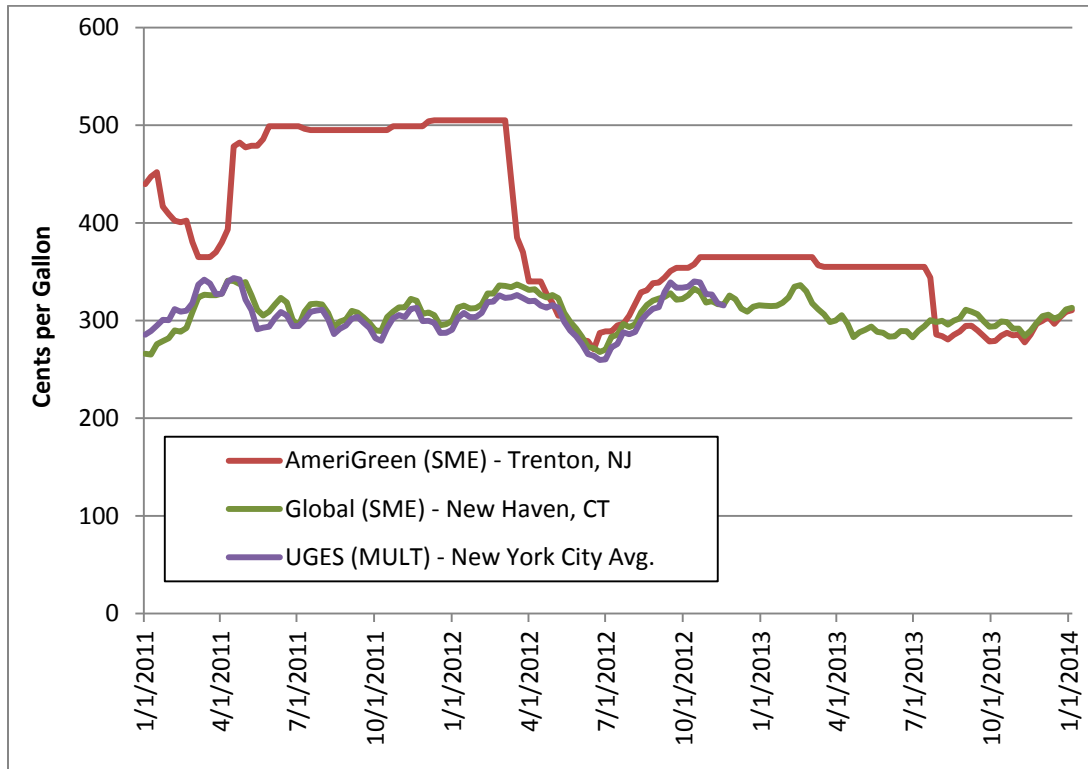
Exhibit 29 shows B99 rack prices in New York City, Trenton, NJ, and New Haven, CT. The prices shown are for individual suppliers in the respective markets. In Trenton, AmeriGreen is the supplier marketing B99. The prices reported are for B99 produced from soy methyl esters (SME) and do not include the Renewable Identification Number (RIN) credit, a topic that will be discussed in greater detail later in this section. In New Haven, Global reports their pricing for SME without the RIN price as well. In New York City, the supplier shown is Ultra Green Energy Services (UGES). Their price is a composite B99 price for biodiesel processed from multiple feedstocks (MULT), and like the other rack prices, also excludes the RIN price. The UGES rack price shown is an average of prices at racks in the Bronx, Brooklyn, Long Island, Mt. Vernon/Westchester, New Hyde Park, New York, and Queens. Although there was some slight pricing deviation in early 2011 between the Bronx and Mt. Vernon/Westchester racks as compared to the others, all racks sold at parity for the vast majority of the period. As seen in the exhibit, the prices in New Haven and NYC tracked closely from 2011-2012.¹⁴⁵ Meanwhile, the price in Trenton diverged from the other two markets during most of 2011 and into 2012, before collapsing in April 2012 and tracking closely with the other rack markets throughout the remainder of the year. However, Trenton and New Haven again diverged through the first half of 2013 until converging again in the latter half of the year.

¹⁴³ Platts, “U.S. Drivers See Growing Biodiesel Blends,” *Oilgram Price Report*, March 1, 2013.

¹⁴⁴ Rack prices are wholesale truckload sales or smaller where title transfers at a terminal.

¹⁴⁵ UGES stopped posting NYC terminal rack prices after November 2012.

Exhibit 29: B99 Price at Mid-Atlantic Terminal Racks (Excluding RIN Credits)

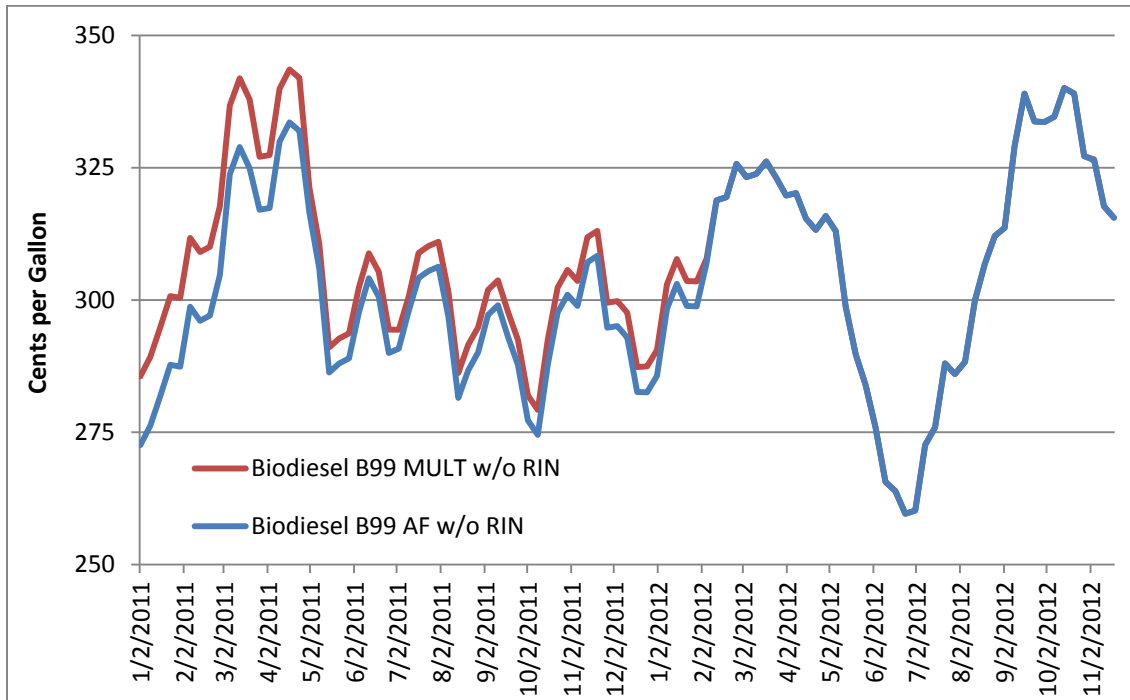


Source: Oil Price Information Service, 2014.

NYC Terminal Locations: Bronx, Brooklyn, Long Island, Mt. Vernon/Westchester, New Hyde Park, New York, and Queens.

In addition to their multiple feedstock biodiesel (denoted “MULT”) prices, UGES also reported a B99 price for biodiesel processed from animal fat (denoted “AF”). Exhibit 30 plots the weekly wholesale price of B99 by feedstock, supplied by UGES as recorded by OPIS. The animal fat biodiesel sold at a slight discount to UGES’s multiple feedstock biodiesel in 2011 by 3-13 cents per gallon (cpg), but the two were priced identically for most of 2012, as seen in Exhibit 30 below. Overall, these rack prices in NYC fluctuated between about 260 cpg and 345 cpg over the past couple years. Again, it is important to note that these prices exclude the associated RIN value of the biodiesel, an important component of biodiesel pricing.

Exhibit 30: Average UGES B99 Price at NYC Terminal Racks (Excluding RIN Credits)



Source: Oil Price Information Service, 2013.

Terminal Locations: Bronx, Brooklyn, Long Island, Mt. Vernon, New Hyde Park, New York, and Queens.

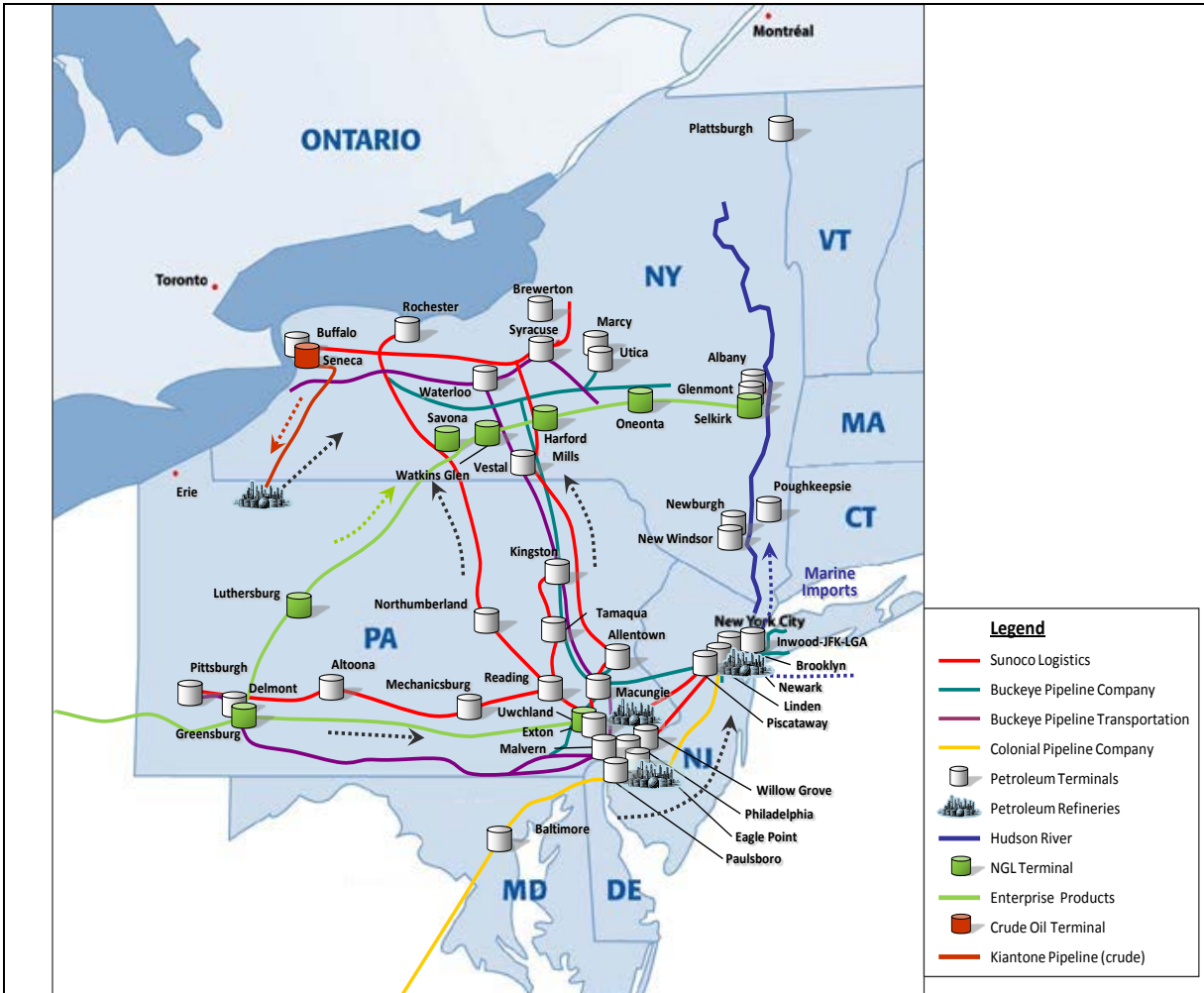
5.1.2 ULSD Pricing

Ultra-Low Sulfur Diesel (ULSD) is petroleum diesel with a maximum sulfur content of 15 parts per million (ppm). Starting in 2006, U.S. refineries are required to produce ULSD as the Environmental Protection Agency (EPA) enacted mandates for the transition of on-road diesel fuel to the new ULSD standards. Since that time, NYC has followed the initiative to cleaner air emissions from fuel consumption by adopting a similar mandate for heating oil consumed in the City. Currently, about 1 percent of buildings in NYC consume No. 4 or No. 6 fuel oil (while the remainder consume cleaner fuels like ULSD, biodiesel, natural gas, or steam), but these fuels are being eliminated as no new permits will be issued for boiler or burners consuming these fuels. Instead, cleaner burning fuels are being mandated for heating such as ULSD, biodiesel, natural gas, and steam.¹⁴⁶

ULSD supply into the Mid-Atlantic originates from: 1) movements along Colonial Pipeline from refineries on the U.S. Gulf Coast; 2) Mid-Atlantic refineries in the Philadelphia, PA and Linden, NJ regions; and 3) marine imports from other markets (domestic and foreign). Exhibit 31 below is a map of petroleum infrastructure in the Mid-Atlantic region.

¹⁴⁶ PlanNYC, "Heating Oil Regulations," accessed June 2013, <http://www.nyc.gov/html/gbee/html/codes/heating.shtml>.

Exhibit 31: Distribution of Transportation in the Mid-Atlantic

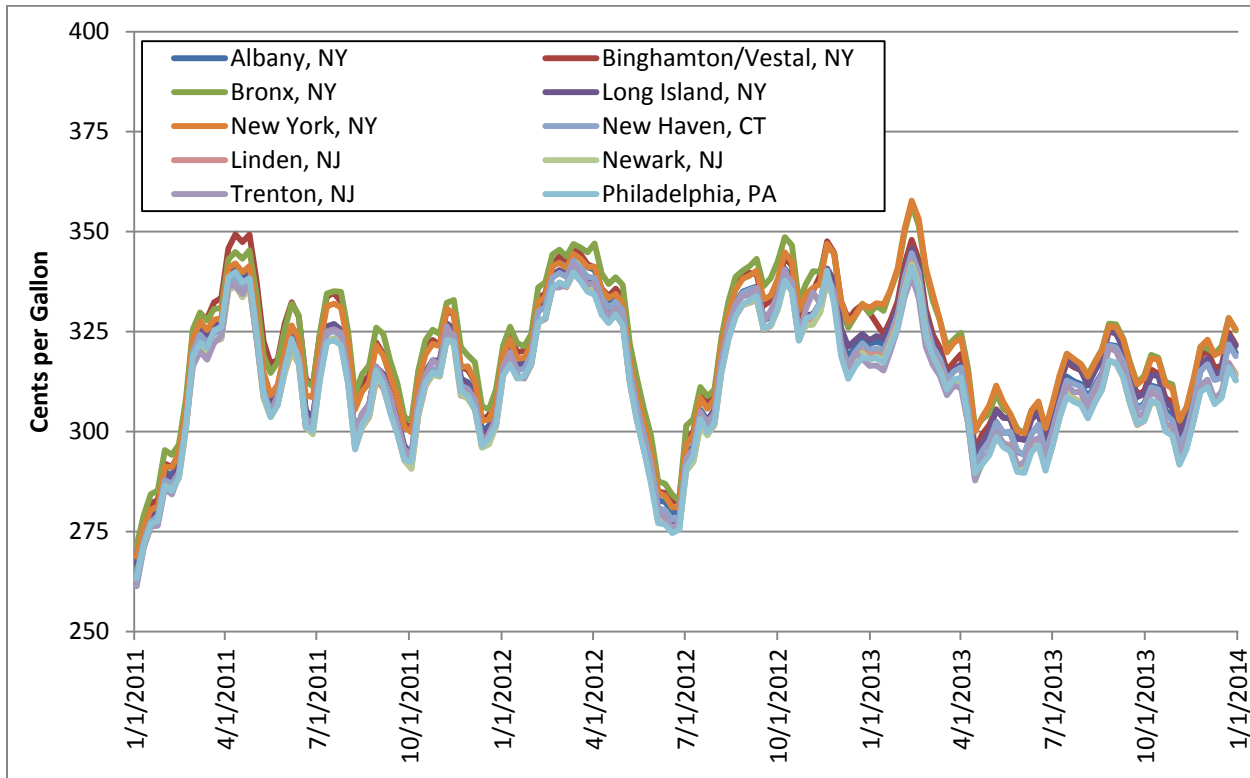


Source: ICF International original production, 2012.

Note: This map was put together using information from Petroleum Terminal Encyclopedia; OPIS/Stalsby, 2012 Edition. Valid through September 2012.; 2011 SEC Company 10-K Filings; Company websites and presentations.

ULSD average rack prices in the Mid-Atlantic fluctuated between 260 and 360 cpg from 2011-2013. The markets analyzed in Exhibit 32 show that various rack markets in the region have closely tracked each other over the period. The spread between the maximum daily price at all the racks and the minimum daily price at all the racks averaged about 11 cpg over the period. For example, on January 3, 2011, the spread was 10.22 cpg as the Bronx was priced at 271.57 cpg (highest rack price that day) and Trenton, NJ was 261.35 cpg (the lowest rack price that day). This narrow spread of about 11 cpg indicates that the markets analyzed are heavily linked by sources (supply costs) and customers (selling prices).

Exhibit 32: ULSD Terminal Rack Prices by City



Source: Oil Price Information Service, 2014.

Under the new New York State requirement that No. 2 fuel oil must meet ULSD sulfur specifications, ULSD is being used in heating oil. Aside from differences in how on-road and off-road ULSD are dyed (they are dyed different colors for tax purposes), they are essentially the same product. In fact, since this product is used both as heating oil and vehicle fuel, the Platts *Oilgram Price Report* published an article stating the shippers on Colonial Pipeline are classifying their product as heating oil even if it is ULSD in order to avoid EPA mandates under RFS2.

*Two ultra low sulfur diesel grades shipped on the Colonial Pipeline from the US Gulf Coast to New York Harbor look exactly alike and have the same quality specifications, according to the pipeline’s own specifications. But by calling one ultra low sulfur heating oil instead of ULSD, traders have been able to sell the former at a steep discount to the latter.*¹⁴⁷

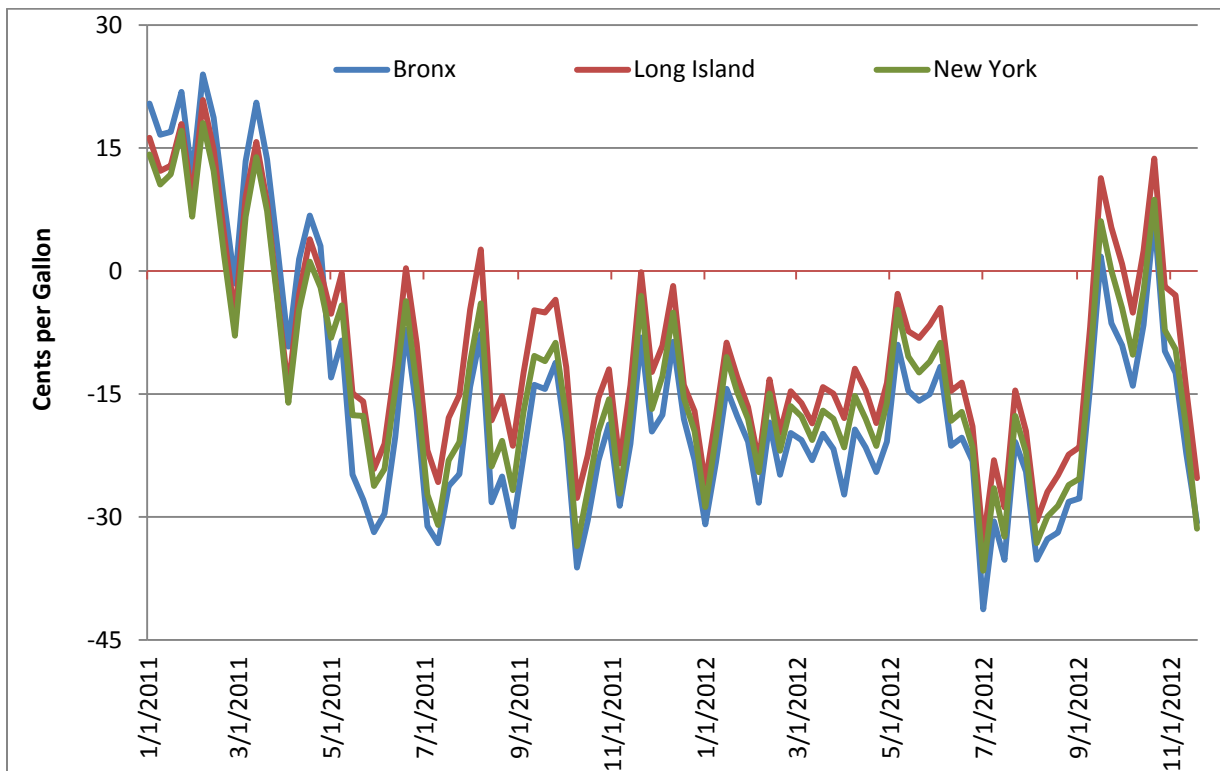
ULSD and biodiesel are close substitutes in the NYC distillate market. As the price of ULSD and biodiesel diverge (i.e. one is sold at a premium to the other), the less expensive fuel can substitute for the more expensive fuel. For instance, if biodiesel becomes price-advantaged relative to ULSD, heating oil and diesel suppliers will incorporate more biodiesel into their fuel to reduce costs. This substitution will most likely occur at the margin because blending large quantities of biodiesel into fuel blends may require customer notification above certain levels and can have adverse impacts on equipment.

¹⁴⁷ Platts, “Ultra Low Sulfur Heating Oil Avoids RIN Costs,” *Oilgram Price Report*, March 11, 2013.

As potential substitutes, the spread between ULSD and biodiesel is important to suppliers of both fuels. Exhibit 33 below shows the spread between NYC terminal rack prices for ULSD and UGES’s average B99 price (excluding the associated RIN) at the respective racks for multiple feedstock biodiesel (“MULT”).

As seen in the exhibit, biodiesel was priced at a premium to ULSD during the first quarter of 2011, but fell to significant discounts throughout the remainder of 2011 and much of 2012. These discounts, which reached over 40 cpg, indicate a significant price advantage for biodiesel producers, a perspective that has been corroborated by stakeholder interviews for this report. However, it is important to note that the price of biodiesel is materially impacted by the existence of the BMETC. Since this provides blenders with a \$1/gallon tax credit, blenders are willing to discount their prices by up to \$1/gallon.

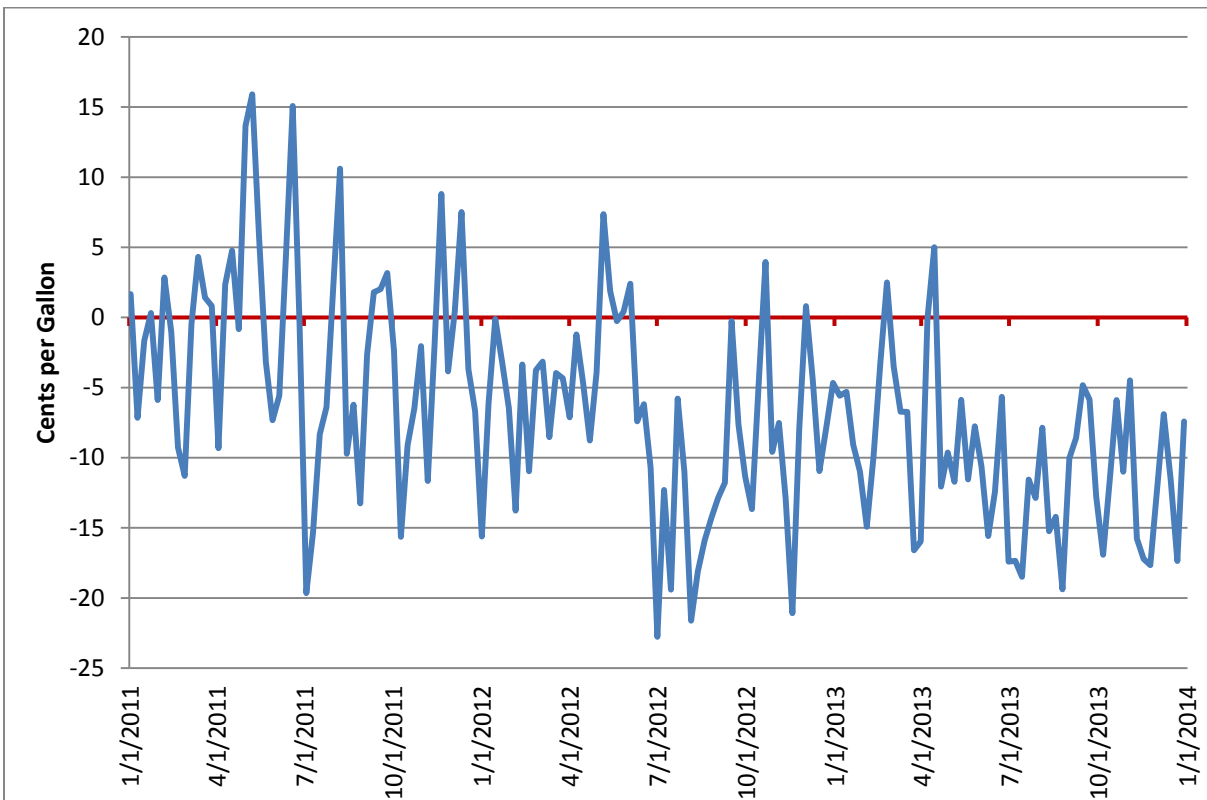
Exhibit 33: Average Price Spread between B99 MULT and ULSD at NYC Region Terminal Racks (Excluding RIN Credits)



Source: Oil Price Information Service, 2013.

A similar trend existed over the same period and continued through 2013 in the New Haven, CT rack market. Exhibit 34 plots the spread between B99 SME at Global’s New Haven, CT rack versus the average ULSD rack price from 2011 through 2013. Again, the spread tended to be negative (though fluctuated) throughout the period, as B99 SME in New Haven averaged about 6.6 cpg below ULSD.

**Exhibit 34: Average Price Spread between B99 SME and ULSD at New Haven, CT
(Excluding RIN Credits)**

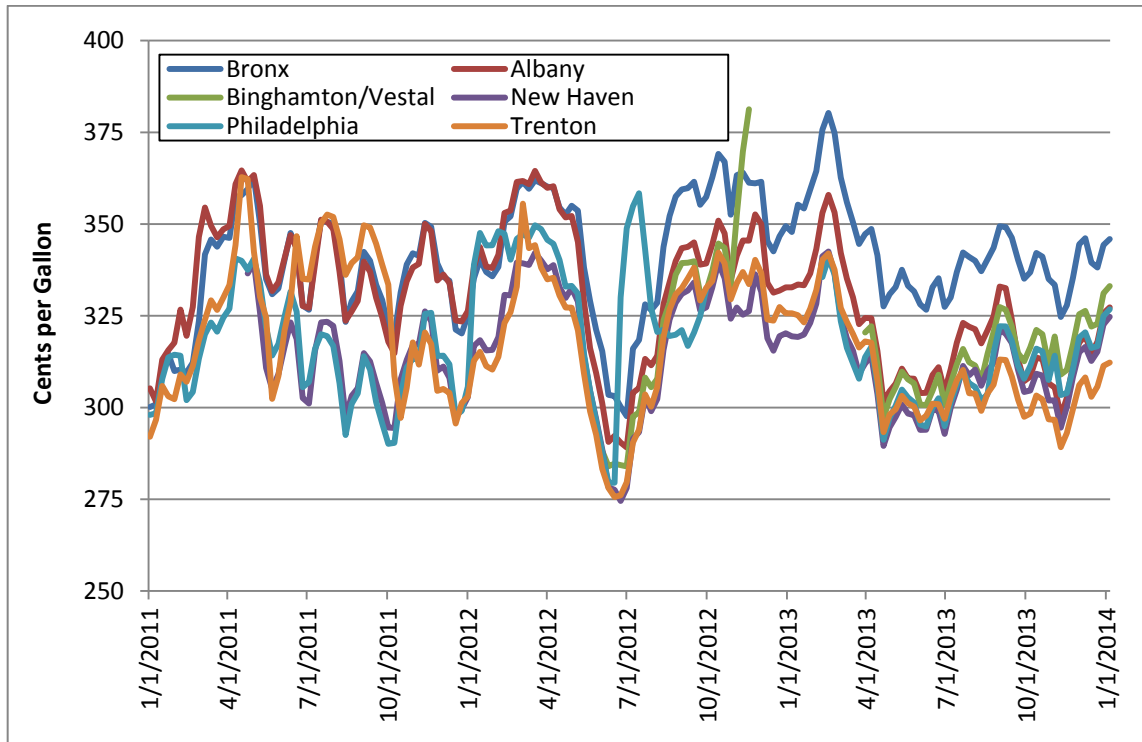


Source: Oil Price Information Service, 2014.

5.1.3 Blended Biodiesel Pricing

OPIS also reports rack pricing for a variety of biodiesel blended fuels in the Mid-Atlantic. Exhibit 35 shows the average weekly price of B20 SME in various Mid-Atlantic markets. The exhibit shows that the price in each region has tracked relatively closely over the period. The max-min spread over the period ranged from 13-71 cpg over the period and averaged about 29 cpg.

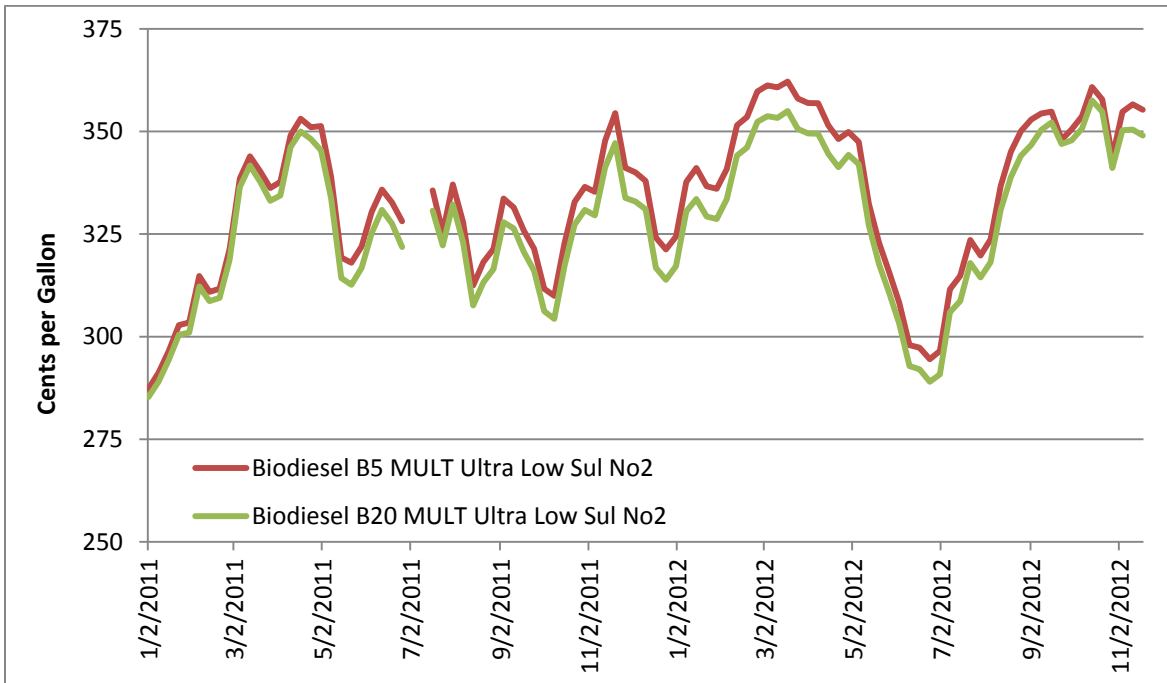
Exhibit 35: Average Mid-Atlantic B20 SME Terminal Rack Prices (Excluding RIN Credits)



Source: Oil Price Information Service, 2014.

Exhibit 34 indicated that biodiesel tended to sell at a discount to ULSD during the period in NYC, which is corroborated in the following exhibit. Exhibit 36 shows the average price for B5 MULT and B20 MULT supplied by UGES at various racks in NYC. Throughout the time period, B5 sold at a premium to B20 by 1-7.5 cpg. The fact that this spread was positive throughout the time period indicates a higher ULSD price compared to MULT biodiesel as the ULSD price is a larger factor in B5 pricing (determines ~95 percent) than in B20 pricing (determines ~80 percent).

Exhibit 36: B5 MULT and B20 MULT NYC Terminal Rack Prices (Excluding RIN Credits)



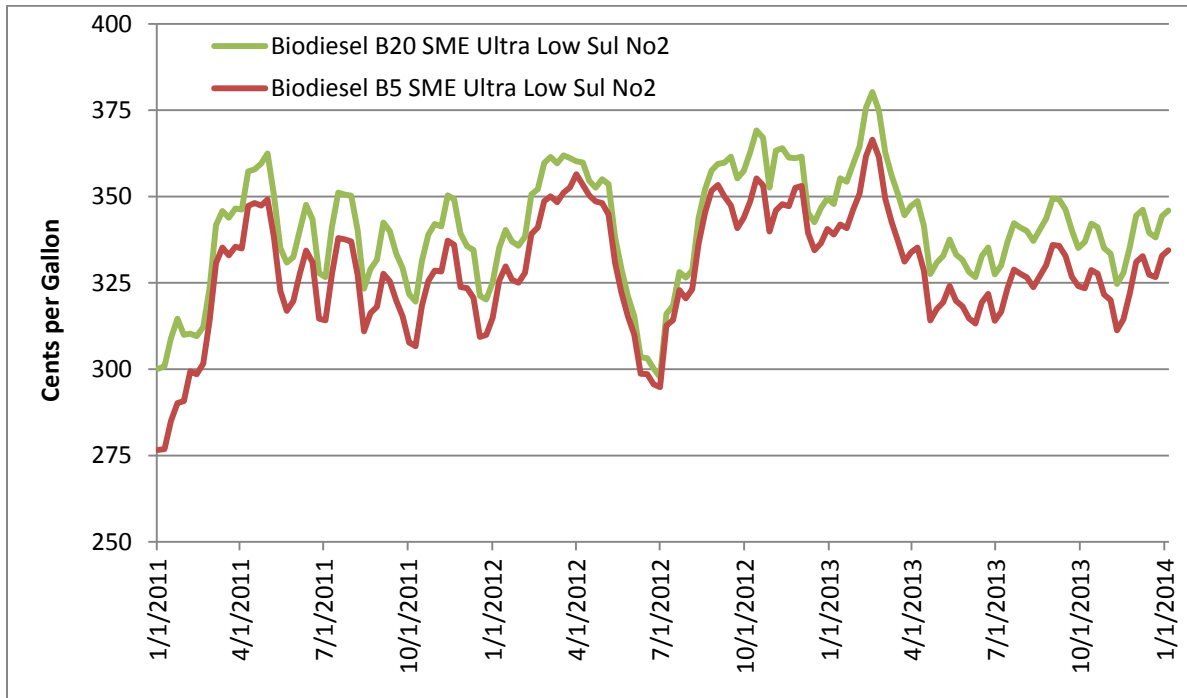
Source: Oil Price Information Service, 2013.

Terminal Locations: Bronx, Brooklyn, Long Island, Mt. Vernon, New Hyde Park, New York, and Queens.

Of the few participants operating in the NYC biodiesel industry, some operate under specific supply contracts and do not market their product outside of these arrangements. According to OPIS, the only supplier posting rack prices for MULT biodiesel in the NYC area from 2011-2012 was UGES. In November 2012, UGES stopped posting all of its biodiesel prices and it is not clear what caused this change in market participation. Consequently, drawing definitive conclusions from biodiesel rack pricing alone can be difficult due to data limitations, highlighted by Exhibit 37 below.

The exhibit plots B5 SME and B20 SME at Bronx racks in which B20 is priced *higher* than B5, which is counter to the trend seen in the prior exhibits. This spread was always positive and ranged from between 2.9 and 24.4 cpg over the period. Moreover, this same relationship was seen elsewhere (e.g. Long Island, Albany, and Binghamton).

Exhibit 37: Average Bronx B5 SME and B20 SME Rack Prices (Excluding RIN Credits)



Source: Oil Price Information Service, 2014.

Part of the dichotomy is likely due to a few inconsistencies between the pricing series. First, there is a difference in feedstock quality between SME and MULT. SME biodiesel is a more premium product (e.g. has a lower cloud point) than MULT biodiesel and thus can command a premium price. SME biodiesel is also more expensive to produce as soybeans have been priced extremely high relative to other feedstocks as noted in Section 2.1.2.1.1. Exhibit 29 showed AmeriGreen’s B99 SME pricing was at a significant premium before collapsing and tracking closely with the other two markets. Meanwhile, UGES’s B99 MULT and Global’s B99 SME tracked very closely. This close relationship insinuates price parity for SME and MULT, not a price premium as would be inferred by Exhibit 37.

Another discrepancy is the supplier in Exhibit 33 and Exhibit 36 was UGES, but the suppliers in Exhibit 37 are Sprague and Hess – and only Sprague for B20 SME prior to January 2013. For B5, Hess’s average price was about 3.5 cpg above the Sprague price, but this spread reached premiums of over 17 cpg (and discounts of 9.5 cpg) since 2011. For B20, Hess, which only started to market B20 in January 2013, always sold at a premium to Sprague and averaged 11.5 cpg above the Sprague price. This is a much larger spread than would be expected in a fully open and competitive market. For reference, the pricing spread for ULSD between the Bronx and New York (which are two separate locations) averaged only 2 cpg from 2011-2013.¹⁴⁸

Lastly, Exhibit 34 showed B99 SME in New Haven, CT was cheaper than ULSD. This was reflected in the B5 and B20 pricing in which B20 SME was priced slightly below B5 SME (about 1 cpg on average).

¹⁴⁸ These pricing series are shown in Exhibit 32.

Without more proprietary insight into the nature of each firm’s biodiesel business (e.g. contract pricing, volumes sold, discounts allowed, customers, etc.), it is difficult to reach firm conclusions upon all the market dynamics in this niche industry. The general assessment from the information available is that biodiesel, incorporate of the BMETC, was price-competitive with petroleum diesel through 2013. However, the BMETC expired on December 31, 2013 and this could translate into higher biodiesel and biodiesel blended fuel prices.

5.1.4 Biodiesel Pricing Insights

The preceding pricing charts indicate a few important points regarding the biodiesel market in and around NYC.

1. The charts indicate a strong relationship between the prices for biodiesel and diesel at the various racks within the region, an indicator (though not confirmation) of a competitive supplier market.
2. The available pricing information highlights some anomalies in the Northeast biodiesel markets. Although the rack price assessments provide differing indications of price-advantages, it appears that biodiesel, under the existence of the BMETC, was price-competitive with petroleum ULSD in the region.
3. On the margin, biodiesel and petroleum diesel are close substitutes. Suppliers of fuel that is less than 5 percent biodiesel are not required to divulge the presence of biodiesel. As a result, suppliers have the option to use the less expensive fuel without marketing implications as long as the fuel remains below the 5 percent threshold.
4. The data offers insight into the wholesale supply price for biodiesel, petroleum diesel, and blended fuel, which is the primary component of retail prices to consumers (after adding additional costs like transportation/distribution, retail profit, and taxes).

5.2 Renewable Identification Number (RIN) Prices and Fraud

The Renewable Identification Number (RIN) is a very important financial mechanism within the RFS2. As mentioned earlier, renewable fuel producers and importers register their product using a RIN, which is a unique 38-character numeric code that identifies a variety of aspects about the specific volume of biodiesel (i.e. name of producer/importer, year produced/imported, etc.). RINs provide a basic currency for the credit, trading, and use by obligated parties to demonstrate compliance and track the volumes of renewable fuels utilized to comply with the RFS2 standard. Obligated parties include gasoline and diesel producers or importers and blenders that produce gasoline from nonrenewable blendstocks.

RINs remain with the physical quantity of renewable fuel until it is blended into transportation fuel, when the associated RIN can be separated from the physical quantity and used for RFS2 compliance, saved for future RFS2 compliance, or traded. If obligated parties are not able to meet their RFS2 blending requirements, they can purchase RINs from others to fulfill their obligations (similar to the idea of emissions trading under cap-and-trade). RIN trading led to the establishment of EPA’s Central Data

Exchange (CDX) where RINs can be purchased and sold to meet the mandate.¹⁴⁹ In addition, RINs that are generated in a certain year but not used to meet that year's mandate, can be rolled over, up to 20 percent, into the following year for compliance. For example, 20 percent of an obligated party's 2011 compliance could be met with RINs generated in 2010 that were either saved or purchased from others in the market.

The RFS2 has generated additional value for biodiesel. Not only is the product valuable as a fuel or blending component, but it also carries an additional value in that it helps obligated parties avoid hefty non-compliance penalties under the RFS2. Consequently, the price of biodiesel is determined by: 1) the costs associated with biodiesel production (e.g. feedstock, capital, labor, etc.); 2) transportation and distribution costs (e.g. trucking, rail, barge, storage, etc.); and 3) the value of RINs, which is a function of biodiesel/RIN supply, market demand, a speculative component for those seeking arbitrage opportunities in the RIN market, and penalties for non-compliance. Moreover, the biomass-based diesel requirement is a subset of the overall advanced biofuels mandate, so RINs from biodiesel count 1-for-1 for the biomass-based diesel requirement but also count as 1.5 RINs toward the advanced biofuel mandate.

The RFS2 volume mandates alone incentivize producers to produce biodiesel as obligated parties will demand the product. The RIN system allows for the electronic transfer of credits so that market segmentation (i.e. an obligated party far from supply has the opportunity to fulfill the requirement without burdening transportation costs) does not occur. High RIN prices may be advantageous for producers, and can help spur biodiesel production and deployment into the market. However, these higher prices may trickle down the supply chain with adverse impacts on consumers. For consumers in NYC, high RIN prices may result in the form of higher heating oil and ULSD prices.

In practice, the U.S. biodiesel RIN market has seen positive prices over the last few years, indicating that the RFS2 mandate is above the market equilibrium quantity. Since the beginning of 2011, the price of a U.S. biodiesel RIN peaked at \$2 per RIN (September 2011), and fell below \$0.25 in November 2013. Exhibit 38 shows the average daily price of biodiesel RINs since 2011. (Note: one physical gallon of biodiesel generates 1.5 RINs under the RFS2. These prices are on a RIN basis and not a physical gallon basis.¹⁵⁰)

¹⁴⁹ U.S. Department of Agriculture, "The Renewable Identification Number System and U.S. Biofuel Mandates," November 2011, <http://www.ers.usda.gov/media/138383/bio03.pdf>.

¹⁵⁰ EPA, "Questions and Answers on Changes to the Renewable Fuel Standard Program (RFS2), accessed June 2013, <http://www.epa.gov/oms/fuels/renewablefuels/compliancehelp/rfs2-aq.htm>.

Exhibit 38: U.S. Average Daily Biodiesel RIN Price



Source: Oil Price Information Service, 2014.

The value of RINs will flow to producers as they are the starting point for biodiesel into the market. However, this increased price of biodiesel to obligated parties (costs plus RIN value) was partially offset by the Biodiesel Mixture Excise Tax Credit (BMETC), which provided a tax break through the end of 2013 of \$1 for each gallon of pure biodiesel, agri-biodiesel, or renewable diesel blended with petroleum diesel to produce a mixture containing at least 0.1 percent diesel fuel.

5.2.1 RIN Fraud

Though the RFS2 has successfully spurred biodiesel industry growth, there have been some setbacks. The discovery of several RINs fraud cases in 2011 and 2012 triggered an industry-wide move to formalize the process of auditing and validating RINs at biodiesel facilities across the country. Small biodiesel companies who rely on RINs sales for a portion of their income are unable to sell them now without undergoing an audit. The auditing requirement has created a significant backlog for the audit services, exacerbating an already lengthy process and causing some smaller producers to stop production. Additionally, the fraud cases have reduced obligated party interest in purchasing RINs from small and medium-sized producers, resulting in a gap of RIN value of 15 to 20 cents.

The entire integrity of the RIN system has been questioned in part due to the EPA review process. The obligated parties are concerned about the validity of the RINs due to the length of time it takes to verify a

RIN (as long as one year) with producers being expected to financially back RINs for as long as two years.¹⁵¹

5.3 Federal, State, and Local Biomass-Based Diesel Policies

In recent years, there have been a wide variety of local, state, and federal incentives and programs put into place to encourage the production, distribution, and consumption of biofuels throughout the country. Exhibit 39 below summarizes the programs and incentives relevant to biodiesel. These incentives have been met with a varying degree of support and angst by the biofuel industry, the petroleum industry, and the general public. The following section outlines a number of biodiesel-related incentives that are currently in-place.

Exhibit 39: Summary Table of Regulations and Incentives

Regulation or Incentive	Producer	Supplier	Distributor	Consumer
Federal				
Energy Policy Act (EPAct)	X	X	X	X
Energy Independence and Security Act (EISA)	X	X	X	X
Renewable Fuel Standard (RFS2)	X	X	X	
Alternative Fuel Transportation Program				X
Alternative Fuel Infrastructure Tax Credit			X	X
Biodiesel Income Tax Credit			X	X
Biodiesel Mixture Excise Tax Credit	X	X	X	
Advanced Biofuel Production Payments	X			
Second Generation Biofuel Producer Tax Credit	X			X
State				
Biofuel Production Tax Credit	X			
Biofuel Fueling Infrastructure Funding		X	X	
Clean Heating Fuel Tax Credit				X
Biofuel Station Initiative Program		X	X	
Alternative Fuel Vehicle and Fueling Infrastructure Funding and Technical Assistance			X	
Alternative Fuel Tax Exemption and Rate Reduction				X
Local				
Local Law 43-2010 (B2 Mandate)	X	X	X	X
Emissions from the Use of #4 and #6 Fuel Oil in Heat and Hot Water Boilers and Burners				X
Clean Heat Program				X

Source: Alternative Fuels Data Center, 2013.

¹⁵¹ Edgar Ang, "RINs fraud debacle shuts New York State biodiesel plant indefinitely," Oil Price Information Service (OPIS), February 14, 2012, Gaithersburg, MD.

5.3.1 Federal

5.3.1.1 Regulations

Federal regulations concerning biodiesel include vehicle acquisition and fuel use requirements for state and alternative fuel provider fleets and the renewable fuel standard (RFS2) program. Under the Energy Policy Act (EPAAct) of 1992, qualified state government and alternative fuel provider fleets that operate, lease, or control 50 or more (with at least 20 used within a single metropolitan area) light-duty vehicles must purchase and use AFVs. In 2007, DOE issued an Alternative Compliance¹⁵² rule, which allows fleets to choose a petroleum reduction path instead of AFVs through a waiver from DOE.¹⁵³

5.3.1.2 Incentives

Currently, the federal government offers a host of incentives to encourage the use and production of alternative fuels, including biodiesel. While many of these incentives did expire December 31, 2011, additional funds were allocated through Public Law 112-240, which was enacted January 8, 2013.

To encourage the growth of biodiesel infrastructure, fueling equipment for diesel fuel blends containing a minimum of 20 percent biodiesel installed between January 1, 2006, and December 31, 2013, is eligible for a tax credit of 30 percent of the cost, not to exceed \$30,000. Fueling station owners can get credits for installations at each location. Qualified residential fueling equipment installed prior to December 31, 2013 may be eligible for a tax credit up to \$1,000.¹⁵⁴

In addition, taxpayers delivering or using neat biodiesel (B100) may be eligible for \$1.00 incentive per gallon of biodiesel, agri-biodiesel, or renewable diesel. This tax credit is applicable to fuel delivered between January 1, 2005 and December 31, 2013, with the exception of tax year 2010.¹⁵⁵ It should be noted that B100 is not readily available at any fueling locations in NYC, so this tax credit is difficult to claim for NYC residents.

A federal tax credit is also available to eligible biodiesel blenders that are registered with the IRS. Eligible biodiesel blenders will receive a tax incentive in the amount of \$1.00 per gallon of pure biodiesel, agri-biodiesel, or renewable diesel blended with petroleum diesel to produce a mixture containing at least 0.1 percent diesel fuel. This tax credit is applicable to fuel blended between January 1, 2005, and December 31, 2013, with the exception of tax year 2010.¹⁵⁶

With regard to biodiesel production payments, eligible producers of advanced biofuels, or fuels derived from renewable biomass other than corn kernel starch, may receive payments from the U.S. Department of Agriculture Bioenergy Program for Advanced Biofuels (Section 9005). Payment amounts relate to the quantity and duration of production, net nonrenewable energy content of the advanced biofuel, the

¹⁵² DOE, "10 CFR Part 490 Alternative Fuel Transportation Program; Final Rule," accessed June 2013, http://www1.eere.energy.gov/vehiclesandfuels/epact/pdfs/fed_reg.pdf.

¹⁵³ AFDC, "Vehicle Acquisition and Fuel Use Requirements for State and Alternative Fuel Provider Fleets", accessed June 2013, <http://www.afdc.energy.gov/laws/law/US/347>.

¹⁵⁴ AFDC, "Alternative Fuel Infrastructure Tax Credit," accessed June 2013, <http://www.afdc.energy.gov/laws/law/US/10513>.

¹⁵⁵ AFDC, "Biodiesel Income Tax Credit," accessed June 2013, <http://www.afdc.energy.gov/laws/law/US/396>.

¹⁵⁶ AFDC, "Biodiesel Mixture Excise Tax Credit," accessed June 2013, <http://www.afdc.energy.gov/laws/law/US/395>.

number of program participants, and the available funding. Funding is subject to congressional appropriations through fiscal year 2013.¹⁵⁷

A second generation biofuel producer is eligible for a \$1.01 per gallon tax incentive for qualified uses. Second generation biofuel includes fuel produced from lignocellulosic or hemicellulosic renewable feedstock or algae, cyanobacteria, or lemna. This tax credit is available between January 1, 2009 and December 31, 2013.¹⁵⁸

5.3.2 New York State

5.3.2.1 Regulations

There are currently no state regulations relating to biomass-based diesel in place in New York. While the federal EPA State and Alternative Fuel Provider Fleet regulations apply to state fleets, these regulations were passed and are monitored for compliance by the federal government.

5.3.2.2 Incentives

Not all biodiesel use in NYC comes as a result of a mandate - there are also several financial incentives offered by NYS to encourage the use of biodiesel. These incentives benefit biodiesel producers, retail fueling station owners, and private biodiesel infrastructure owners.

With regard to biodiesel production incentives, biofuel producers in New York State may qualify for a state tax credit of \$0.15 per gallon of biodiesel (B100) or ethanol produced after the production facility has produced, and made available for sale, 40,000 gallons of biofuel per year. The maximum annual credit available is \$2.5 million per taxpayer for no more than four consecutive taxable years per production facility. If the taxpayer is in a partnership or is a shareholder of a New York S corporation, the maximum credit amount is applied at the entity level, so the aggregate credit allowed to all partners or shareholders may not exceed \$2.5 million. Additional requirements may apply. This credit expires December 31, 2019.¹⁵⁹

In addition, the Clean Heating Fuel Credit provides a state tax credit for residential and commercial bioheat oil users through 2016. This tax credit offers consumers a tax credit of 1 cent per gallon for each percent of biodiesel in heating oil up to 20 cents per gallon (B20).¹⁶⁰

More in the way of financial assistance for on-road projects, the New York State Energy Research and Development Authority (NYSERDA) administers the Biofuel Station Initiative Program, which provides funding to retail fueling stations offering E85 and biodiesel blends in the state, and to petroleum terminal operators to store, blend, and dispense biofuels. NYSERDA will reimburse up to 50 percent of new biofuel dispensing installation costs, including equipment, storage tanks, and associated piping equipment, up to \$50,000 per site. NYSERDA also reimburse up to 50 percent for new biofuel storage,

¹⁵⁷ AFDC, "Advanced Biofuel Production Payments," accessed June 2013, <http://www.afdc.energy.gov/laws/law/US/8503>.

¹⁵⁸ AFDC, "Second Generation Biofuel Producer Tax Credit," accessed June 2013, <http://www.afdc.energy.gov/laws/law/US/10515>.

¹⁵⁹ State of New York, "New York Tax Law 28*2 and 187-c," accessed March 2013, <http://public.leginfo.state.ny.us/menugetf.cgi?COMMONQUERY=LAWS>.

¹⁶⁰ U.S. Department of Energy Database of State Incentives for Renewables and Efficiency (DSIRE), "New York Incentives/Policies for Renewables & Efficiency," accessed June 2013, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NY54F.

handling, blending, and rack dispensing equipment, including installation costs, up to \$150,000 per site. Technical assistance is also available for new and existing biofuel equipment design and construction specifications, biofuel specific permits and waivers to local and state code officials, and staff training.¹⁶¹

NYSERDA also provides financial and technical assistance to fleet managers interested in AFVs and alternative fuel equipment.¹⁶²

5.3.3 New York City

5.3.3.1 Regulations

As a result of NYC local law 2010/043, NYC requires all commercial and residential heating oil used in the city to have a two percent biodiesel composition beginning October 1, 2012. Legislative language of the law states that:

“After October 1, 2012, no person shall cause or permit the use in any building in the city or deliver to any building in the city for use in such building, heating oil that is fuel oil grade No. 2, No. 4 or No. 6 containing less than two percent biodiesel by volume. The provisions of this subdivision shall not apply to the use or delivery of heating oil for use in an emergency generator or for use in a boiler where heating oil from a dual-use tank supplies both such boiler and an emergency generator.”

In addition, No. 4 and No. 6 fuel oil are being phased out. In order to renew a Certificate of Operation, boiler and burners may no longer use No. 6 oil unless owners demonstrate that PM and NO_x emissions would be equal to or less than No. 4 oil emissions.¹⁶³ By January 1, 2030, owners need to have phased out No. 4 oil for ultra-low sulfur No. 2 fuel oil unless they can demonstrate that emissions would be equal to or less than ULS2 emissions.¹⁶⁴ Extensions may be granted by the DEP depending on replacement/conversion costs and installer constraints. Boiler owners may consult the NYC Clean Heat database to determine when their boilers need to be converted or replaced.¹⁶⁵

The Clean Heat program also provides information about the transition to No. 2 and biodiesel.¹⁶⁶ Building owners, managers, and residents can find resources related to technical assistance, financing, and incentives. The Clean Heat staff provide technical and regulatory assistance, fuel payback analysis, and lists of qualified contractors and financing companies.

¹⁶¹ AFDC, “New York Incentives and Laws,” accessed June 2013, http://www.afdc.energy.gov/laws/state_summary/NY.

¹⁶² AFDC, “New York Incentives and Laws,” accessed June 2013, http://www.afdc.energy.gov/laws/state_summary/NY.

¹⁶³ NYC Department of Environmental Protection, “Promulgation of Amendments to Chapter 2 of Title 15 of the Rules of the City of New York Rules Governing the Emissions from the Use of #4 and #6 Fuel Oil in Heat and Hot Water Boilers and Burners,” accessed June 2013, http://www.nyc.gov/html/dep/pdf/air/heating_oil_rule.pdf.

¹⁶⁴ Natural gas can also be substituted.

¹⁶⁵ <http://www.nycleanheat.org/sites/nycleanheat.org/files/Clean%20Heat%20Data%20for%20Distribution.xlsx>

¹⁶⁶ NYC Mayor’s Office, “NYC Clean Heat,” accessed June 2013, <http://www.nycleanheat.org/>

5.3.4 Impact of New Regulations and Incentives on Biomass-Based Diesel Infrastructure

5.3.4.1 Infrastructure Growth Related to Federal Tax Credits

With regard to fueling station growth as a result of the federal Alternative Fuel Infrastructure Tax Credit, it is difficult to ascertain whether fueling station openings in the city were a result of the credit. Of the three B20 fueling stations operating in NYC today, two of the three stations began operation in 2009, which was well within the funding period.

5.4 Regulatory Standards on Quality for Biomass-Based Diesel

5.4.1 ASTM International and NYS Fuel Quality Requirements

Blenders of biodiesel are permitted to vary the concentration in diesel fuel depending on which standard is adhered to for the final blend. Low-level biodiesel blends can range from B2 to B5 mixed with the conventional diesel fuel to meet ASTM International specification D975. Higher blends between of B6 to B20 must meet ASTM International specification D7467. Any blend over B20 must meeting the ASTM International specification D6751. The differences between these specifications can be shown in the table below.

Exhibit 40: Key fuel property differences between ASTM certified on-road diesel (ASTM D975) and B100 (D6751)

Fuel Properties	D975 (>B5) ¹⁶⁷	D6751 ¹⁶⁸
Specific Gravity at 15 °C	0.846	0.88
Kinematic viscosity (mm ² /s) at 40 °C	1.3-4.1	4.0-6.0
Flash Point (° C)	60-80	100-170
Cloud Point (° C)	-35 to 5	-3 to 12
Pour Point (° C)	-35 to -15	-5 to 10
Cetane number	40-55	48-65

Source: ASTM International, 2013.

The U.S. Internal Revenue Service (IRS) and EPA are the responsible agencies in charge of enforcing compliance with ASTM D6751 standards. As federal tax credits for biodiesel are only available to biodiesel producers whose fuel meets ASTM D6751 specifications, every producer claiming the credit must obtain a certificate stating that their biodiesel is registered with the EPA. If this certificate of validation is fraudulent, responsible parties will be tried for perjury and upon conviction, fined \$500,000 in the case of a corporation, and \$100,000 in the case of an individual under 26 U.S. Code 7206. In addition, per the Clean Air Act, no motor fuel or motor fuel additive may be sold in the United States

¹⁶⁷ NREL, "Biodiesel Handling and Use Guide (Fourth Edition), Revised December 2009, p. 11, accessed June 2013, <http://www.nrel.gov/docs/fy09osti/43672.pdf>.

¹⁶⁸ NREL, "Biodiesel Handling and Use Guide (Fourth Edition), Revised December 2009, p. 11, accessed June 2013, <http://www.nrel.gov/docs/fy09osti/43672.pdf>.

unless it is registered with the EPA.¹⁶⁹ To ensure compliance with proper EPA registration, Part 40, section 80.4 of the Code of Federal Regulations states that,

The Administrator or his authorized representative, upon presentation of appropriate credentials, shall have a right to enter upon or through any refinery, retail outlet, wholesale purchaser-consumer facility, or detergent manufacturer facility; or the premises or property of any gasoline or detergent distributor, carrier, or importer; or any place where gasoline or detergent is stored; and shall have the right to make inspections, take samples, obtain information and records, and conduct tests to determine compliance with the requirements of this part.

The above responsibilities are held by the EPA Office of Enforcement and Compliance Assurance and by the Certification and Compliance Division of the Office of Transportation and Air Quality (OTAQ). Responsible parties that violate EPA regulations will be liable for penalties to the U.S. government in amounts of \$25,000 for every day that the violation continues in addition to the monetary amount gained through the violation, per Title 40, Part 80.5 of the Code of Federal Regulations.

In addition, NYS currently conducts routine fuel quality tests for biodiesel blends up to B5 at both retail and blender locations. These tests are conducted through the New York Department of Weights and Measures. The 2012 New York Tax Code, Article 12-A - (282 - 289-F), titled, Tax on Gasoline and Similar Motor Fuel, specifies that NYS biodiesel will be tested based on the following fuel definition:

"Biodiesel" shall mean either "qualified biodiesel" or "unqualified biodiesel." "Qualified biodiesel" means a diesel motor fuel substitute produced from nonpetroleum renewable resources that meets the registration requirements for fuels and fuel additives established by the Environmental Protection Agency under section 211 of the Clean Air Act (42 U.S.C. 7545) and that meets the ASTM International active standard D6751 for biodiesel fuel. "Unqualified biodiesel" means a diesel motor fuel substitute produced from nonpetroleum renewable resources that do not meet the ASTM International active standard D6751 for biodiesel fuel.

Violators of ASTM D6751 in NYS will be issued penalties ranging from \$500 to \$10,000 for cetane and other performance standards and will also be ordered to remove the product.¹⁷⁰

5.4.2 BQ-9000®

The National Biodiesel Accreditation Program is a cooperative and voluntary program for the accreditation of biodiesel producers, marketers, and laboratories called BQ-9000®. The program uses a combination of “ASTM standards for biodiesel (ASTM D6751) and a quality systems program that includes storage, sampling, testing, blending, shipping, distribution, and fuel management practices.”¹⁷¹

¹⁶⁹ NBB, “NBB Fuel Quality Enforcement Guide ASTM D-6751 Enforcement,” accessed June 2013, <http://www.biodiesel.org/docs/ffs-production/fuel-quality-enforcement-guide.pdf?sfvrsn=2>.

¹⁷⁰ NBB, “New York One-Pager (State's Fuel Quality Regulation),” accessed June 2013, <http://www.biodiesel.org/using-biodiesel/fuel-quality-guide/state-fuel-quality-index/viewstate?state=New%20York>.

¹⁷¹ BQ-9000®, “Home Page,” accessed June 2013, <http://www.bq-9000.org/>.

The BQ-9000® certification was established after biodiesel fuel quality issues created problems among end-users. The goal of the program is to encourage public acceptance and confidence in the fuel through a rigorous set of fuel testing requirements by an independent auditor to ensure quality control is fully implemented. NYC has integrated BQ-9000® standards into City biodiesel fuel procurement requirements.

5.4.3 ULSD Requirements

Ultra-low sulfur diesel (ULSD) is a diesel fuel with a substantially lower sulfur content of 15 parts per million (ppm). In 2013, all of the petroleum-based diesel fuel available in the U.S. is ULSD, including all on-road and most off-road diesel fuels. There are some exemptions for non-road, locomotive, and marine diesel fuel refiners which will allow for 500 ppm diesel until December 1, 2014. The adoption of ULSD has generally led to an increase in the cost of the fuel, which has allowed biomass-based diesel to be cost-competitive. As of March 2013, biodiesel was less expensive than ULSD after federal incentives, leading to the widespread blending of biodiesel in areas where supply was readily available.

6 Barriers to Biomass-Based Diesel

6.1 Equipment Limitations

6.1.1 Boiler Compatibility

When used in home heating oil, B5 meets the ASTM International D396 home heating oil specification. All boiler manufacturer warranties cover bioheat blends up to B5, while only a few manufacturer warranties cover bioheat blends over B5. It should be noted that at blends of B6 to B20, bioheat can be used in most boilers with minor to no modifications to the equipment per ASTM D7467, although certain manufacturers do not extend warranty coverage if equipment is damaged by these blends. It is important to note that ASTM is not a regulatory agency; it simply sets and maintains standards related to fuel quality.

6.1.2 On-Road Engine Compatibility

According to the National Renewable Energy Laboratory's (NREL) Biodiesel Handling and Use Guide, diesel vehicles typically do not require modification for blends up to B20. However, the general concern with higher-than-B5 is that such fuels could lead to engine performance issues, such as filter plugging, injector coking, piston ring sticking and breaking, elastomer seal swelling and hardening/cracking, and engine lubricant degradation.

In addition, while engines operating on B20 generally have similar fuel consumption, horsepower, and torque as engines running on petroleum diesel, not all diesel engine manufacturers cover biodiesel use in their warranties. It should be noted that federal law prohibits OEMs from voiding a warranty just because biodiesel was used— biodiesel must be the cause of the failure for an OEM to void a warranty. If an engine experiences a failure that is directly caused by biodiesel use, OEMs are then allowed to void the vehicle warranty.¹⁷²

Every OEM is different with regard to which biodiesel blend levels they will warranty for use in their engines; however, all diesel engine manufacturers warranty their engines for B5 blends and below. The National Biodiesel Board maintains a list of all on-road vehicle original equipment manufacturers (OEMs) supporting B5 and B20. Below is a complete list of their data, which shows each OEM's biodiesel blend warranty threshold.

¹⁷² EPA, "Fuel Considerations," accessed June 2013, <http://www.epa.gov/region7/biofuels/noncombiodiesel/fuel.htm>.

Exhibit 41: OEM Warranties for Biodiesel Use in On-Road Vehicles. Source: NBB, 2012

Engine Warranty Level	OEM Engines Approved for Use with X Biodiesel Blend
B5 and Below	<ul style="list-style-type: none"> • Audi • BMW • Mazda • Mercedes Benz • Mitsubishi • PACCAR – including: • Kenbuilt • Volkswagen <p><i>*Note that Audi, Mercedes Benz, Mitsubishi, and Volkswagen are currently researching B20 coverage.</i></p>
B20 and Below	<ul style="list-style-type: none"> • Chrysler • Cummins • Daimler Trucks • Ferris • Ford (Model Year (MY) 2011 and newer) • GMC and Chevrolet (MY2011 and newer) • HDT USA Motorcycles • Hino Trucks (MY2011 and newer) • International/Navistar • Isuzu Commercial Trucks (MY2011 and newer) • Mack • Perkins • Volvo Trucks

* Note that the above warranty thresholds are only valid if the biodiesel blends used meet ASTM D6751 and for B20, ASTM 7467.¹⁷³ Source: NBB, 2012.

Renewable and cellulosic diesel meets the fuel specification requirements of the ASTM D975 standard for petroleum diesel fuel. Renewable and cellulosic diesel blends can be used without concern in any diesel vehicle, and in fact are indistinguishable from conventional ULSD. Thus it is a hydrocarbon blendstock that can be blended into fungible fuel at any point in the distribution system. In addition, small amounts of vegetable oils or animal fats can be added to the traditional petroleum refining process when producing diesel fuel (co-processing).

6.1.3 Underground Storage Tank and Fueling Dispenser Compatibility

Most underground storage tanks that are manufactured to store petroleum diesel blends can easily store B100;¹⁷⁴ however, it's important to confirm that tank materials such as aluminum, steel, fluorinated polypropylene, and fiberglass make up the tank structure to ensure that degradation does not occur when using biodiesel. These materials must also be used in biodiesel fueling equipment to ensure that piping,

¹⁷³ National Biodiesel Board (NBB), "Biodiesel OEM Support," September 2012, accessed June 2013, <http://www.biodiesel.org/using-biodiesel/oem-information/oem-statement-summary-chart>.

¹⁷⁴ PEI, "UST Component Compatibility Library," accessed June 2013, <http://www.pei.org/PublicationsResources/ComplianceFunding/USTComponentCompatibilityLibrary/tabid/882/Default.aspx>.

spill and release detection equipment, dispensers, and dispenser nozzles are compatible with biodiesel blends.¹⁷⁵ Equipment materials that may lead to oxidation of biodiesel include brass, bronze, lead, zinc, tin, and copper. The U.S. Environmental Protection Agency (EPA) published final guidance on the subject in Volume 76, No. 28 of the Federal Register on July 5, 2011 to assist owners and operators of USTs in complying with the federal UST compatibility requirements promulgated under the authority of Subtitle I of the Solid Waste Disposal Act (SWDA).¹⁷⁶ This guidance applies to biodiesel blends over 20 percent biodiesel that are stored in USTs. Currently, all newly manufactured USTs are compatible with blends of up to 100 percent biodiesel; however, EPA requires all UST manufacturers to provide a statement of compatibility for their products with biodiesel blends.

The NY Fire Department (NYFD) should be consulted on the development of a broader protocol for permitting biodiesel blends in USTs, particularly a program that would mirror EPA requirements. Protocols in consideration should include a variance policy for biodiesel blends above B20. To date, NYFD does not have any written regulations and cannot issue any regulations that would waive or reduce EPA regulations, but can implement more stringent requirements. The City and NYFD should develop a city-wide waiver for biodiesel in city-owned USTs for blends less than B20 and variance requirements for blends above B20.

6.2 Regulatory Barriers

6.2.1 Permitting and Inspection

Numerous permitting and inspection hurdles are required to be addressed before biodiesel storage and production equipment can be placed into service. These regulations are described in detail below.

6.2.1.1 Biodiesel Storage and Dispensing Equipment

Per the NYC Fire Code Chapter 22, Motor Fuel Dispensing Facilities and Repair Garages, “All motor fuel-dispensing facilities, CNG motor fuel-dispensing facilities and repair garages shall be designed, installed, operated and maintained in accordance with Chapter 34 of [the NYC Fire Code], and the construction codes, including the Building Code, the Fuel Gas Code and the Mechanical Code, and, as applicable, NFPA 30A.”¹⁷⁷ The National Fire Protection Association (NFPA) Code 30 states that storage in excess of 25 gallons of methanol is strictly prohibited. This fire code was put in place as methanol is a main component in the production of biodiesel and is considered a moderately hazardous substance. This restriction is also reflected in chapter 3 of the NYS Building Code and Chapter 34 of the NYS Fire Protection Code. In addition, Part 596 of the Environmental Conservation Law: Hazardous Substance Bulk Storage Regulations sets reporting regulations for the use of hazardous substances, including methanol and sodium hydroxide, in certain quantities. Methanol released in quantities above 5,000 pounds to the air or one pound to land or water and sodium hydroxide in quantities above 1,000 pounds to the air and 100 pounds to land or water, must be reported to the NY DEC. These reporting requirements

¹⁷⁵ Oregon Department of Environmental Quality, “Biodiesel and Underground Storage Tank Systems,” accessed June 2013, <http://www.deq.state.or.us/lq/pubs/factsheets/tanks/ust/BiodieselUSTSystems.pdf>.

¹⁷⁶ Federal Register, “Volume 76, No. 2”, July 5, 2011, accessed June 2013, <http://www.gpo.gov/fdsys/pkg/FR-2011-07-05/pdf/2011-16738.pdf>.

¹⁷⁷ New York Department of Environmental Conservation, “Biodiesel Fact Sheet”, accessed June 2013, <http://www.dec.ny.gov/energy/42154.html>.

most often apply to the following storage situations: 1) an aboveground storage tank with a capacity of 185 or more gallons containing a hazardous substance; 2) a UST of any capacity storing a hazardous substance; 3) a truck used to store 2,200 pounds or more of a hazardous substance for more than 90 consecutive days. The installation or alteration of a liquid motor fuel storage and dispensing system must also comply with the EPA regulations set forth in 40 CFR Part 280 as well as the regulations of the NYS Department of Environmental Conservation, as set forth in 6 NYCRR Parts 612, 613 and 614.¹⁷⁸

6.2.1.2 Biodiesel Production Facilities

Firstly, all electrical wiring must comply with the requirements of Section 605, NFPA 30A and the Electrical Code, as applicable and should be approved by a certified electrician.¹⁷⁹ In addition, local zoning laws may prohibit the construction of a biodiesel reactor in certain facilities. The NYC Department of City Planning should be contacted prior to construction regarding zoning districts to determine if a particular district requires a building permit for biodiesel production. An industrial zoning permit may also be required for commercial biodiesel manufacturing activities in NYC. Another consideration is wastewater expelled from the production facility - a NYS Pollution Discharge Elimination System (SPDES) Permit or National Pollution Discharge Elimination System (NPDES) Permit may be required. Production plants must also comply with DEC's 6 NYCRR Part 236 if equipment is operated for 300 hours or more per year. This regulation establishes numerous emission control, monitoring, repair, reporting, and record keeping requirements and compliance is monitored by the DEC.¹⁸⁰

6.2.1.3 Requirements for Underwriters Laboratories Listed Equipment

In some municipalities, biodiesel equipment is required to be Underwriters Laboratories listed (UL is a non-profit company that tests product safety for the public) before it can be put into operation at a public or private fueling site. Insurance companies may also require equipment to be Underwriters Laboratory listed before a contract is signed. In this regard, UL has issued a statement indicating that use of any biodiesel blend up to B5 in standard petroleum diesel fueling equipment does not require special investigation and can be put into operation without modifications. Unfortunately, limited B20 and B100 UL listed equipment is available for dispensing equipment. While it is preferable to install UL listed equipment at fueling sites to ensure compliance with local, state, and federal laws and codes, many times those fueling sites often receive a UL waiver from their local jurisdiction to comply with the compatibility and safety requirements.¹⁸¹

¹⁷⁸ New York City Fire Department, "New York City Administrative Code – Title 29 – New York City Fire Code", accessed June 2013, http://www.nyc.gov/html/fdny/pdf/firecode/2013/fire_code_II26_2008_amended_II37_39_41_64_2009_II2_2013.pdf#page=267.

¹⁷⁹ New York City Fire Department, "New York City Administrative Code – Title 29 – New York City Fire Code", accessed June 2013, http://www.nyc.gov/html/fdny/pdf/firecode/2013/fire_code_II26_2008_amended_II37_39_41_64_2009_II2_2013.pdf#page=267.

¹⁸⁰ New York Department of Environmental Conservation (DEC), "Biodiesel Fact Sheet", accessed June 2013, <http://www.dec.ny.gov/energy/42154.html>.

¹⁸¹ NREL, Biodiesel Handling and Use Guide, Fourth Edition (Revised), January 2009, accessed June 2013, <http://www.nrel.gov/vehiclesandfuels/pdfs/43672.pdf>.

6.3 Other Barriers

6.3.1 Production Facility Financing and Economics

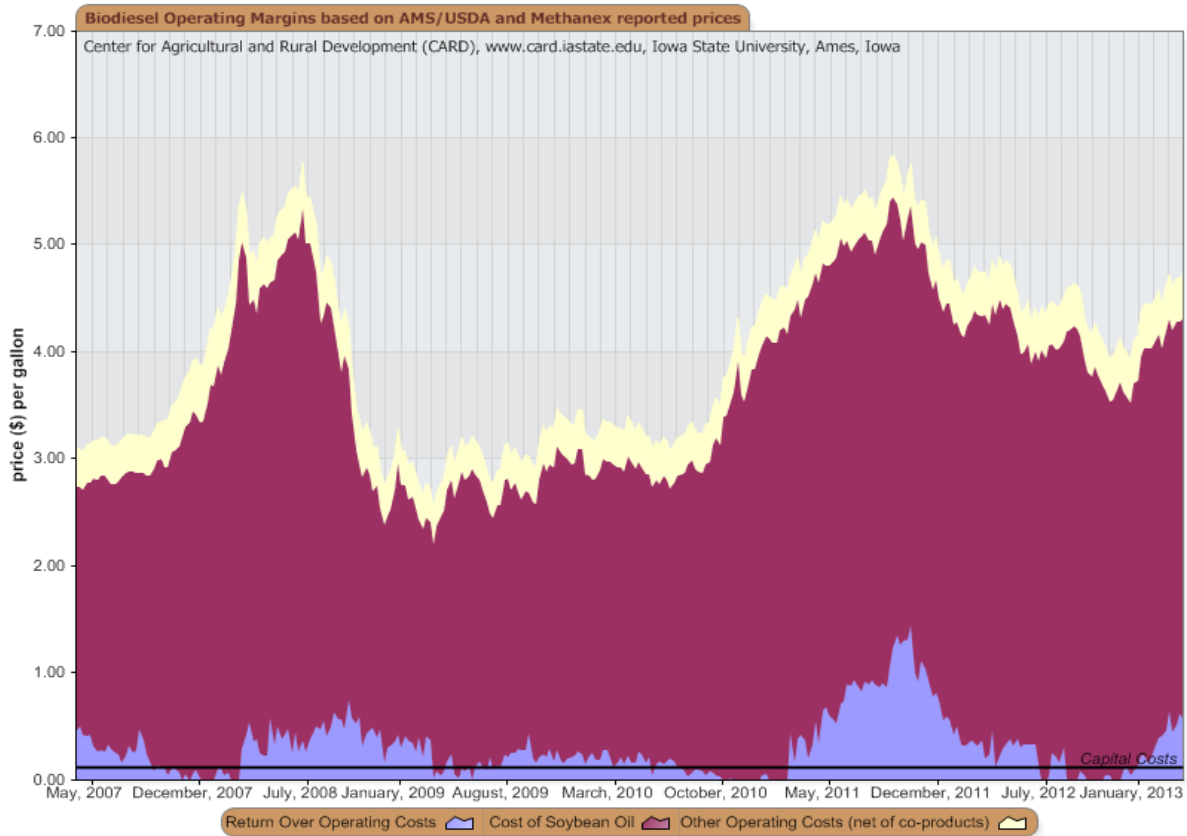
It is unclear what economic advantages there may be with constructing additional biodiesel facilities within the NY Harbor area. In May 2012, a Canadian biodiesel company, Biox Corp., announced plans to locate a 25 million gallon per year facility at the International-Matex Tank Terminal in Bayonne, NJ.¹⁸² The same year, Biox ended the contract agreement citing the significant change in market dynamics.¹⁸³

As mentioned previously, the biodiesel industry is currently operating below capacity in the U.S. Until the Biodiesel Mixture Excise Tax Credit was extended through 2013, the biodiesel industry was operating at razor thin profit margins, or at a loss, particularly for the soybean-based biodiesel industry. The margins on biodiesel are so thin because the industry has to price the fuel competitively with diesel. The Center for Agricultural and Rural Development (CARD) at Iowa State tracks estimated soybean-based biodiesel returns on operating costs such as the cost of soybean oil (assuming 7.6 lbs. of soy per gallon of biodiesel), the price of methanol (reported by Methanex), and other net operating costs (e.g., net of glycerin or other co-products). They report their estimates on a monthly basis back to May 2007 as shown in Exhibit 42. CARD notes that a positive return on operating costs does not indicate profits, as there are other costs not included in their estimates (e.g., plant financing, returns to capital). They estimate a fixed capital costs such as plant financing at \$0.12 per gallon, represented by the black line on the graph.

¹⁸² Erin Voegelé, "Biox says its new biodiesel plant will be built in NY Harbor," Biodiesel Magazine, May 14, 2012, <http://www.biodieselmagazine.com/articles/8496/biox-says-its-new-biodiesel-plant-will-be-built-in-ny-harbor>.

¹⁸³ Tina Davis, "Biox Ends Agreement to Build Biodiesel Plant in New York Harbor," Bloomberg News, December 24, 2012, <http://www.bloomberg.com/news/2012-12-24/biox-ends-agreement-to-build-biodiesel-plant-in-new-york-harbor.html>.

Exhibit 42: Estimated Biodiesel Operating Margins, May 2007– February 2013



Source: CARD, Iowa State University, 2013.¹⁸⁴

As biodiesel use increases in the future, the costs of producing and delivering biodiesel are expected to decrease, but only marginally.¹⁸⁵ The price differential between biomass-based diesel and conventional diesel will likely be impacted as much or more by an increase in the price of diesel than a decrease in production costs. As shown in the table above, feedstock costs comprise the majority of the production costs; therefore it is essential that an inexpensive feedstock is identified. At the time of publication, it is difficult to forecast whether there will be future economically-viable opportunities to build additional biodiesel facilities in the greater NYC area and could be the subject of additional analysis.

6.3.2 Cold Weather Performance and Filter Changes

Biodiesel blends do not offer comparable cold weather performance to petroleum diesel (cloud point and pour point temperatures are higher than for petroleum diesel). Therefore, block heaters may be required in cold climates for biodiesel blend use. In addition, biodiesel acts as a solvent and can release deposits from within the fuel system of the engine, which can clog fuel filters. More frequent filter changes (especially early on in using biodiesel) may be needed. Even at lower blends, such as B5, industry representatives have expressed concern about cold weather causing clogged fuel filters. If considering local requirements for on-road biodiesel, these, and other concerns, should be addressed.

¹⁸⁴ CARD, Iowa State University, accessed June 2013, http://www.card.iastate.edu/research/bio/tools/hist_bio_gm.aspx.

¹⁸⁵ CARD, Iowa State University, accessed June 2013, http://www.card.iastate.edu/research/bio/tools/hist_bio_gm.aspx.

7 Biomass-Based Diesel Opportunity Areas

7.1 Potential for Biomass-Based Diesel Growth

There is potential to increase the amount of biodiesel consumed in NYC. To assess this potential the following outlook discussion was put together using data from EIA’s Annual Energy Outlook. EIA’s outlook forecasts distillate and residual fuel oil consumption for the Mid-Atlantic region, which is comprised of New York, New Jersey, and Pennsylvania.¹⁸⁶ Although distillate fuel oil is comprised of No. 1, No. 2, and No. 4 fuel oil, No. 2 comprises the vast majority of distillate fuel oil consumption in the Mid-Atlantic (98 percent) according to EIA consumption data.

The total fuel oil (distillate and residual) projection was apportioned using a historical average to estimate what portion of the Mid-Atlantic’s consumption was attributable to New York State. Once the New York State consumption volumes were estimated, a further apportioning took the ratio of historical NYS consumption from EIA with NYC consumption data provided by PlaNYC to estimate the City’s consumption outlook for total fuel oil. The estimated NYC consumption was apportioned based on historical ratios of heating oil and on-road diesel to total fuel oil from PlaNYC. The PlaNYC consumption is a conservatively low number as it does not account for all consumption in NYC. Two cases were then drawn where biodiesel penetrates 5 percent and 20 percent of the total fuel oil market segment.

7.1.1 Consumption Outlook

The following table estimates consumption projections for distillate and residual fuel oil, and biodiesel consumption under three scenarios for NYC from 2013 through 2017. The growth rate for heating oil consumption is expected to be about 2.4 percent per year for the coming two years (2013-2015) before plateauing.

Exhibit 43: Estimated NYC Biodiesel Consumption Outlook in Heating Oil and Transportation Fuels

Million Gallons per Year					
	2013	2014	2015	2016	2017
NYC Heating Oil and On-Road	1,141.2	1,117.0	1,195.9	1,194.6	1,186.7
NYC B2 Heating Oil	19.6	20.2	20.5	20.5	20.4
NYC B5 Heating Oil	48.9	50.5	51.3	51.2	50.9
NYC B5 On-Road	8.1	8.4	8.5	8.5	8.5
NYC B20 Heating Oil	195.7	201.9	205.1	204.9	203.5

Source: EIA AEO, 2013; PlaNYC, 2012.

¹⁸⁶ Distillate fuel oil is a general classification for one of the petroleum fractions produced in conventional distillation operations. It includes diesel fuels and fuel oils. Products known as No. 1, No. 2, and No. 4 diesel fuel are used in on-highway diesel engines, such as those in trucks and automobiles, as well as off-highway engines, such as those in railroad locomotives and agricultural machinery. Products known as No. 1, No. 2, and No. 4 fuel oils are used primarily for space heating and electric power generation.

In 2013, NYC biodiesel consumption in B2 heating oil is estimated at 20 million gallons. If a B5 heating oil mandate is enacted, a potential of about 49 million gallons of biodiesel is projected to be consumed, an approximate increase of 30 million gallons. Similarly, if a B20 heating oil mandate is enacted, a potential 200 million gallons of biodiesel is projected to be consumed, an increase of approximately 180 million gallons. Lastly, a B5 mandate for the on-road market would equate to about 8.5 million gallons, though some of this is already being consumed in order for suppliers to comply with RFS2 standards.

Biodiesel plants in the region supplying NYC are estimated to be operating at about 30 percent of their 247 million gallon total capacity. Consequently, about 172 million gallons of capacity is idle. Thus for a B5 mandate for both heating oil and transportation, there is sufficient existing capacity in the region to supply biodiesel. However, instituting a B20 mandate may create regional supply constraints. In addition, as the U.S. continued to be a net exporter of biodiesel, these volumes could instead be potentially available for consumption within the U.S. if demand dictates.

7.2 Biomass-Based Diesel Economic Development Opportunities

Very little information is currently available about the potential economic development opportunities for biomass-based diesels, including biodiesel, in New York City. Biofuel studies conducted to date have primarily been through state agencies, such as NYSERDA, as summarized in the subsequent section. Locally, there are two biodiesel facilities currently under construction and anticipated to open in 2013. Currently, the biodiesel market is still relatively small compared to the traditional distillate market, so as part of the research conducted by ICF, no direct jobs were attributed specifically to growth in the biodiesel supply chain, including distributors, marketers, and terminals. It is possible that construction jobs were generated over the past year through infrastructure upgrades, including the installation of blending equipment and the construction and/or retrofit of biodiesel storage tanks, but no documentation with that analysis was available. Finally, it is also possible that some jobs have been generated through the retrofit or upgrade of biodiesel dispensing equipment or the purchase and upgrade of biodiesel-compatible equipment (including vehicles and heating oil equipment), but no documentation with that analysis was available at the time of publication. ICF recommends that the City consider additional economic analysis in these areas to better estimate the past and future opportunities for biomass-based diesel use and consumption.

7.2.1 State Biodiesel Economic Studies

In 2003, NYSERDA released a report, *Statewide Feasibility Study for a Potential New York State Biodiesel Industry*, which generated recommendations to increase biodiesel production in NYS. At the time, distillate fuel represented 3.2 billion gallons and a B2 mandate for both on-road and off-road applications would create a market of 64.1 million gallons, projected to increase to 73.7 million gallons by 2012.¹⁸⁷ If NYS were to supply approximately 40 million gallons of that fuel by 2012 (assuming soybeans grown in New York are crushed and all of the yellow grease used in the state) it would generate an additional \$380 million to the economy and create as many as 1,145 new jobs.¹⁸⁸ The recommendations in the report were not implemented representing a potential lost economic development

¹⁸⁷ NYSERDA, "Statewide Feasibility Study for a Potential New York State Biodiesel Industry," June 2003, p. 1.

¹⁸⁸ This assumes the successful passage of a federal Energy Bill described in the report. NYSERDA, "Statewide Feasibility Study for a Potential New York State Biodiesel Industry," June 2003, pp. 2-4.

opportunity for the State. It is unclear from the report how much development may have taken place in NYC. Even without biodiesel production facilities, there is a cottage industry that has grown in the City to collect feedstock for biodiesel fuels, such as Tri-State Biodiesel, LLC which collects and sells yellow grease for biodiesel production with the ultimate goal of building and operating a 10MGPY production facility in 2013.¹⁸⁹

Additionally, the report included a discussion on investment requirements for the State to accommodate this increase in biodiesel consumption throughout the supply chain. At the time, each of the 85 active deep-water storage terminals, most of which are located in the NYC harbor, would need to determine infrastructure upgrades, such as blending equipment, estimated to cost approximately \$64 million.¹⁹⁰

Another report generated by NYSERDA and the Pace Law School's Energy and Climate Center, the *Renewable Fuels Roadmap and Sustainable Biomass Feedstock Supply for New York State*, evaluated the future of liquid biofuel production and feedstock supplies and potential economic development opportunities from developing a biofuels industry. The majority of the analysis was concentrated around ethanol and the job creation scenarios did not differentiate between the fuels. Additionally, there were a series of scenarios developed which assumed different quantities and types of fuels generated. Under the most conservative scenario (Scenario 1), the modelers assumed that by 2020 there would be 30 million gallons per year of biodiesel production.¹⁹¹ However, aggregated data demonstrated that if at \$3/gasoline gallon equivalent (GGE) of biofuel, the state would be able to generate an estimate 3,800 jobs. If fuel costs increased to \$4/GGE, it could create 7,700 jobs.¹⁹²

7.2.2 Local Biodiesel Economic Development

Locally, two companies have announced plans to open biodiesel facilities in the NYC area: Tri-State Biodiesel, LLC and United Metro Energy Corp.

As mentioned previously, Tri-State Biodiesel, LLC intends to open a 10MGPY facility in spring 2013. Tri-State is unique in that it also collects its own feedstock through existing grease collection services. The company currently employs dozens of workers for the yellow grease and brown grease collection services, including many through a job training program. In October 2012, Metro Fuel Oil Corp. filed for Chapter 11 and sold assets for Metro Biofuels LLC's large, multi-feedstock biodiesel plant under development in Brooklyn to United Refinery (United). The 50 MGPY¹⁹³ multi-feedstock biodiesel production facility was approximately 90 percent complete at the time of the sale.¹⁹⁴ United intends to open the biodiesel facility in early 2013 and produce fuel from locally sourced oils, such as yellow

¹⁸⁹ Interview with Brent Baker & Dearon Duckworth, Tri-State Biodiesel, LLC, March 7, 2013.

¹⁹⁰ NYSERDA, "Statewide Feasibility Study for a Potential New York State Biodiesel Industry," June 2003, p. 2.

¹⁹¹ NYSERDA, "Renewable Fuel Roadmap and Sustainable Biomass Supply for New York," p. ES-7, accessed June 2013, <http://www.nyserda.ny.gov/sitecore/content/Home/Publications/Research-and-Development-Technical-Reports/Biomass-Reports/Renewable-Fuels-Roadmap.aspx>.

¹⁹² NYSERDA, "Renewable Fuel Roadmap and Sustainable Biomass Supply for New York," p. ES-17, accessed June 2013, <http://www.nyserda.ny.gov/sitecore/content/Home/Publications/Research-and-Development-Technical-Reports/Biomass-Reports/Renewable-Fuels-Roadmap.aspx>.

¹⁹³ "Catsimatidis inks deal to make United Metro Energy Corp. the largest heating oil and motor fuels distributor in the New York City metropolitan area," PR Newswire, May 5, 2014. <http://www.prnewswire.com/news-releases/catsimatidis-inks-deal-to-make-united-metro-energy-corp-the-largest-heating-oil-and-motor-fuels-distributor-in-the-new-york-city-metropolitan-area-257932251.html>

¹⁹⁴ Ron Kotrba, "Metro's nearly complete 110 MMgy biodiesel plant up for bid," accessed June 2013, <http://biodieselmagazine.com/articles/8730/metros-nearly-complete-110-mmgy-biodiesel-plant-up-for-bid>.

grease.¹⁹⁵ Plans for specific feedstock and production levels have not been resolved based on an interview with United, and it is likely the plant may start up at lower volumes.¹⁹⁶ There is no estimate at the time of this report on additional employees to operate the biodiesel facility, however it is clear that United will require a skilled workforce and supporting workforce (parts, equipment, services, etc.) which will clearly contribute to the local economy annually through their direct and indirect spending, including local property taxes.

It is unclear if additional production facilities will open in the greater NYC area in the future. Based on the estimates for the collection of local feedstocks, including yellow grease and brown grease, it is possible that additional, smaller facilities could be opened creating additional jobs and revenue for the local economy. However, it is important to note that the bulk of this locally-produced biodiesel will not be purchased by the area's largest biodiesel consumer, the City of New York. Given the current restrictive procurement requirements for cloud point (as discussed previously), biodiesel produced from these feedstocks will have difficulty meeting the fuel quality requirements.

¹⁹⁵ Interview with Fred Martin, Vice President of Supply and Transportation, United Refining, April 5, 2013.

¹⁹⁶ Interview with Fred Martin, Vice President of Supply and Transportation, United Refining, April 5, 2013.

8 Future Biodiesel Supply

8.1 Feedstock Supply Potential

8.1.1 Plant-Based Feedstock Potential

Biomass-based diesel faces the challenge of expanding available feedstock sources on a finite amount of agricultural land and competition from market demands for food, fiber, grazing, and construction. As of 2007, 408.0 million acres were used for crop production in the United States and EPA estimates the available land has declined due to development pressure from urban areas.¹⁹⁷ The University of Missouri estimates that in the 2011/2012 marketing year,¹⁹⁸ the 13 most harvested crops in the U.S. account for 337.0 million acres of planted land.¹⁹⁹ Exhibit 44 below shows that the top five crops grown in the U.S. in 2011 account for 268.7 million acres of land, or approximately 87 percent of agricultural land use.

Exhibit 44: Five Most Planted Crops in U.S. in 2011

Crop	Planted Area (million acres)	Top 5 Share %	Cash Receipts from Sales (\$ billion)
Corn (grain)	91.9	27.3	63.9
Soybeans	75.1	22.3	37.6
Hay	55.7	16.5	6.7
Wheat	54.4	16.1	14.6
Cotton	14.4	4.3	8.3
Top 5 Total	291.5	86.5	131.1
Top 13 Total	337.0	100.0	143.0*

Source: University of Missouri, 2013.²⁰⁰

* \$143.0 billion total is based on total crops. Source: EPA, 2013.²⁰¹

The two most planted crops from the table above – corn and soy – are also the two dominant plant-based feedstock sources for biodiesel (inedible corn oil and soy oil). Exhibit 45 below illustrates the projected production from these two feedstock sources, as well as from canola oil and cellulosic sources. Soy oil is currently the primary feedstock for biodiesel. In 2012, soy oil accounted for 75 percent of the vegetable oil feedstock share; however, inedible corn oil has been gaining market share and surpassed canola oil in the summer of 2012. Because of the increased market for corn ethanol, inedible corn oil byproduct is being extracted to produce biodiesel feedstock. The University of Missouri forecasts corn oil's share of the feedstock market will increase from 11 percent in 2012 to 22 percent in 2018; however, soy oil will still maintain a 74 percent market share in 2018.

¹⁹⁷ EPA, "Land Use Overview," accessed October 2013, <http://www.epa.gov/agriculture/ag101/landuse.html>.

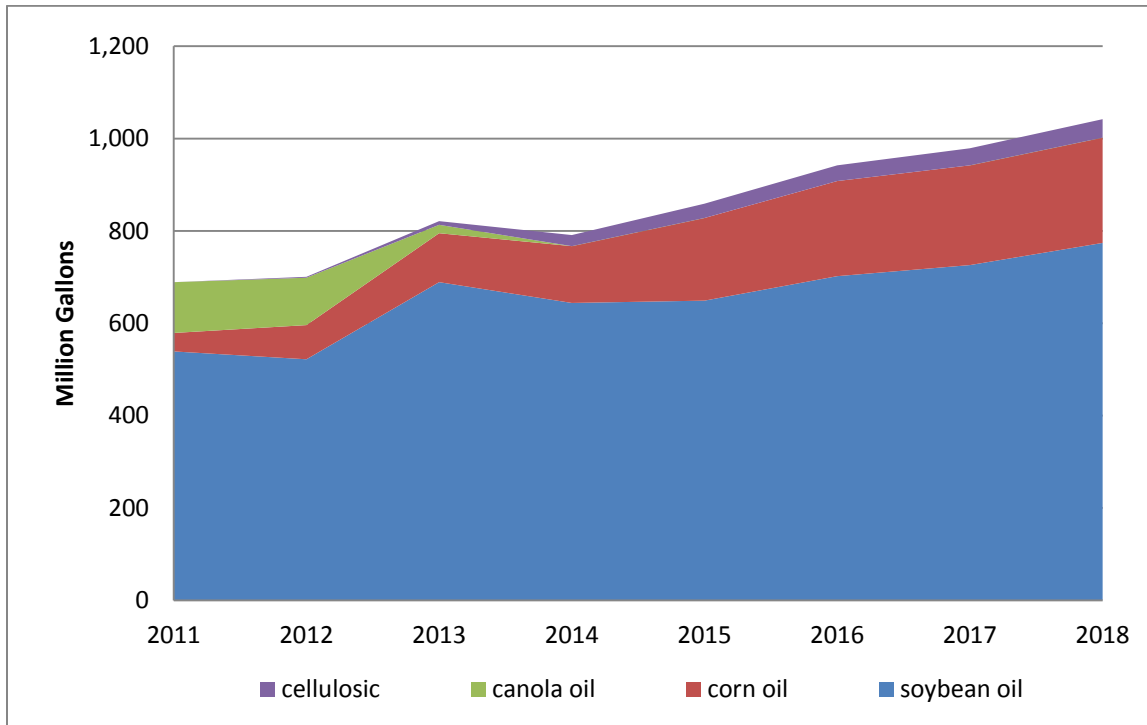
¹⁹⁸ The marketing year for crops runs from October through September.

¹⁹⁹ Integrated Policy Group, Division of Applied Social Sciences, University of Missouri, "August 2013 Baseline Update for U.S. Agricultural Markets," August 2013, p. 11, accessed October 2013, http://www.fapri.missouri.edu/outreach/publications/2013/FAPRI_MU_Report_04_13.pdf.

²⁰⁰ Integrated Policy Group, Division of Applied Social Sciences, University of Missouri, "August 2013 Baseline Update for U.S. Agricultural Markets," August 2013, p. 11, accessed October 2013, http://www.fapri.missouri.edu/outreach/publications/2013/FAPRI_MU_Report_04_13.pdf.

²⁰¹ EPA, "Major Crops Grown in the United States," accessed October 2013, <http://www.epa.gov/agriculture/ag101/cropmajor.html>.

Exhibit 45: Projection of Plant-Based Feedstock for Biodiesel



Source: University of Missouri, 2013.²⁰² Canola oil from EIA, 2013.²⁰³

The future for canola oil is uncertain as the only U.S. based biodiesel plant using canola filed for bankruptcy in March 2013.²⁰⁴ This may be due to the higher price of canola compared to soy. Although canola oil can produce 22 percent more gallons of biodiesel per acre, the price of canola oil is 27 percent higher than the price of soy oil in the U.S.²⁰⁵ It has also been suggested that canola may have declined as a fuel feedstock by becoming a preferred substitute for soy oil in the food industry.²⁰⁶

There are second generation cellulosic sources such as crop residue and purpose-grown trees, which do not require dedicated cropland. However, the market share for second generation feedstock continues to be minimal and the lack of reliable data makes it difficult to quantify that market share.²⁰⁷ Nevertheless, the University of Missouri projects these feedstock sources to acquire a 4 percent market share by 2018.

As Exhibit 46 illustrates, 18.9 billion pounds of soy oil was produced in the 2010/2011 marketing year and 2.7 billion pounds were used as feedstock for biodiesel representing approximately 14 percent of

²⁰² Integrated Policy Group, Division of Applied Social Sciences, University of Missouri, “August 2013 Baseline Update for U.S. Agricultural Markets,” August 2013, p. 11, accessed October 2013, http://www.fapri.missouri.edu/outreach/publications/2013/FAPRI_MU_Report_04_13.pdf.

²⁰³ EIA, “Monthly Biodiesel Production Report: U.S. Inputs to Biodiesel Production,” July 2013, Table 3, accessed October 2013, <http://www.eia.gov/biofuels/biodiesel/production/table3.pdf>.

²⁰⁴ Biofuels Digest, “Inland Empire Oilseeds files Chapter 7 as biodiesel plant hit by soaring canola costs,” accessed October 2013, <http://www.biofuelsdigest.com/bdigest/2013/03/18/inland-empire-oilseeds-files-chapter-7-as-biodiesel-plant-hit-by-soaring-canola-costs/>.

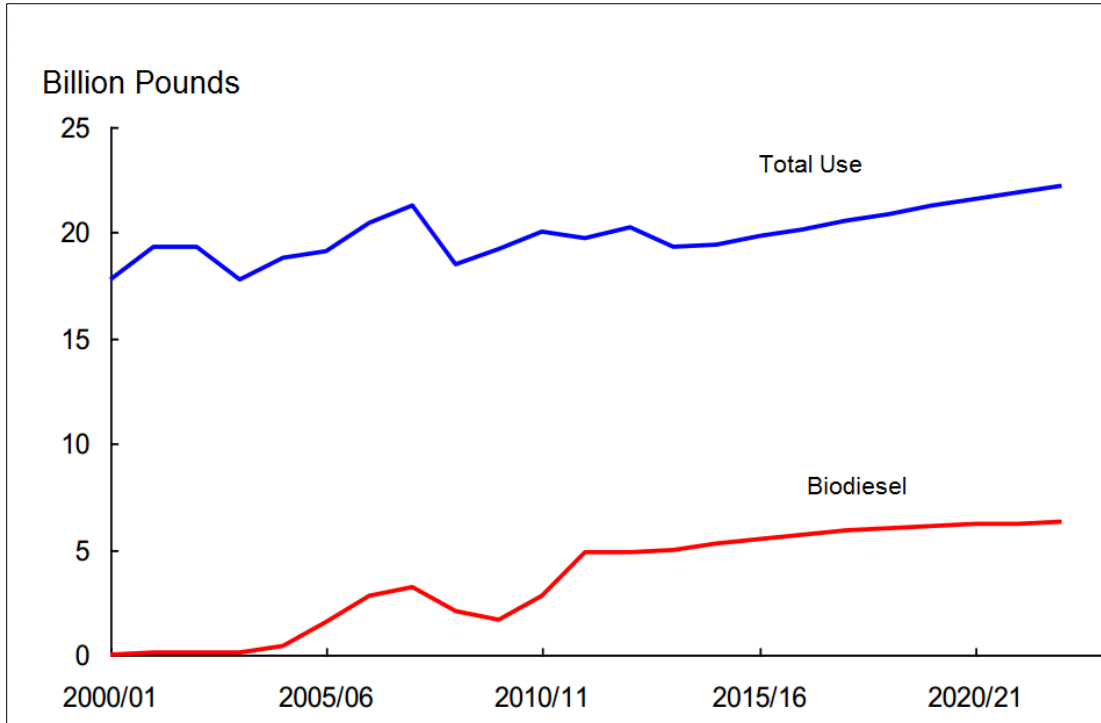
²⁰⁵ Brookes, Graham, “The Production and Price Impact of Biotech Corn, Canola, and Soybean Crops,” 2010, accessed October 2013, <http://www.agbioforum.org/v13n1/v13n1a03-brookes.pdf>.

²⁰⁶ Agricultural Marketing Resource Center, “Feedstocks Used for U.S. Biodiesel: How Important is Corn Oil?” accessed October 2013, http://www.agmrc.org/renewable_energy/biodiesel/feedstocks-used-for-us-biodiesel-how-important-is-corn-oil/.

²⁰⁷ BR&Di, “Increasing Feedstock Production for Biofuels: Economic Drivers, Environmental Implications, and the Role of Research,” 2008, p. XV.

domestic soybean production. Soy oil as a biodiesel feedstock is projected to increase to 6.3 billion pounds by 2022/2023, a 29 percent share of total soy oil production.

Exhibit 46: Share of Soybeans Used for Biodiesel



Source: EIA, 2013.²⁰⁸

In 2011, DOE updated the “Billion-Ton Study” which develops scenarios to estimate whether the U.S. could feasibly produce a billion tons of biomass annually by 2030 in order to replace 30 percent of the petroleum fuels on the road with renewable fuels. The model analyzes factors such as market prices, crop yields, and sustainability on shifts in land for agriculture and energy crops. The report determined agricultural lands could sustainably produce two million dry tons of agricultural feedstock for biodiesel.

At current yield rates, DOE predicts that by 2030, four million dry tons could be produced through total land utilization, different crop rotation strategies, and selection of more productive crops.²⁰⁹ Using these figures, the U.S. could double fuel crop production, allowing for significant expansion of plant-based biomass-based feedstock.

At 4 percent growth in yield rates, DOE predicts that by 2030, biomass feedstock from land resources could increase by over seven times the amount of biomass used today. Forest residues are not expected to

²⁰⁸ Capehart, Tom, “Outlook for Biofuel Feedstock Supply,” March 2013, accessed October 2013, <http://www.eia.gov/biofuels/workshop/presentations/2013/pdf/presentation-10-032013.pdf>.

²⁰⁹ U.S. Department of Energy, “U.S. Billion-Ton Update: Biomass Supply for a Bioenergy and Bioproducts Industry,” August 2011, accessed October 2013, http://www1.eere.energy.gov/bioenergy/pdfs/billion_ton_update.pdf.

be used as a feedstock source for biodiesel, but could be used for cellulosic diesels. DOE does not forecast a significant change in forestlands.²¹⁰

Feedstocks for biodiesel currently have a relatively low yield per acre of planted land. For example, soy-based biodiesel requires one acre of land for every 60 gallons of biodiesel.²¹¹ For the marketing year 2010/2011, 680 million gallons of biodiesel were produced from soybean oil, which required 12 million acres of land. Using the study projections, 4 million dry tons in 2030 would require 17.8 million acres.

There is potential to increase the supply of land. For instance, Cai et al. estimates that the U.S. can convert 106-168 million acres of abandoned, degraded, and low quality lands to grow second generation fuel crops such as low-input high-diversity (LIHD) mixtures of grassland species.²¹² However, the authors note that not all this land may be suitable for growing crops and low quality land is typically used as pastureland.

In addition to these significant land needs, food oils have high transportation costs.²¹³ The cost to produce a gallon of biodiesel from soy oil is currently \$1.25 more than from yellow grease.²¹⁴ As a result, it is important to consider other feedstock sources, which are discussed in the following sections.

8.1.2 Animal-Based and Waste Oil Feedstock Potential

Animal based feedstocks, which include rendered animal fats (e.g., choice white grease, beef tallow, and poultry fat) and recycled oils and greases, currently comprise a significant portion of biodiesel feedstock. In July 2013, a total of 978 million pounds of animal-based and waste oil feedstock were used to produce biodiesel. After soy oil and inedible corn oil, the next two largest sources of feedstocks were yellow grease (97 million pounds) and beef tallow (45 million pounds).²¹⁵ Currently, rendered animal fats make up nearly one-third (11.6 billion gallons) of the U.S. lipid production.²¹⁶ In 2011, biodiesel from animal fats and recycled oils comprised approximately 16 percent and 8 percent of total biodiesel production respectively in the U.S.²¹⁷ In 2012, the percent of animal-based feedstocks slightly declined with approximately 12 percent of production, but recycled oils increased to 12 percent of the total biodiesel production. Future production of animal fats and recycled oils will directly depend on human consumption. According to the Food and Agricultural Policy Research Institute, U.S. per-capita meat

²¹⁰ U.S. Department of Energy, "U.S. Billion-Ton Update: Biomass Supply for a Bioenergy and Bioproducts Industry," August 2011, accessed October 2013, p. XXV, http://www1.eere.energy.gov/bioenergy/pdfs/billion_ton_update.pdf.

²¹¹ Sadaka, Samy, "Biodiesel," accessed October 2013, http://www.uaex.edu/Other_Areas/publications/PDF/FSA-1050.pdf.

²¹² Cai, Ximing, Xiao Zhang, and Dingbao Wang, "Land Availability for Biofuel Production," *Environ. Sci. Technol.* 2011, 45, p. 334–339.

²¹³ Concentric Energies & Resource Group, "U.S. Biofuels Industry: Mind the Gap," April 2010, accessed October 2013, http://www1.eere.energy.gov/bioenergy/pdfs/us_biofuels_industry_report.pdf.

²¹⁴ EIA, "Projected Production Costs for Diesel Fuel by Feedstock, 2004-2013," accessed October 2013, <http://www.eia.gov/oiaf/analysispaper/biodiesel/pdf/tbl3.pdf>.

²¹⁵ EIA, "Monthly Biodiesel Production Report," September 2013, accessed October 4, 2013, <http://www.eia.gov/biofuels/biodiesel/production/>.

²¹⁶ Biodiesel Magazine, "Recycling for Renewables", June 21, 2007, accessed June 2013, <http://www.biodieselmagazine.com/articles/1707/recycling-for-renewables>.

²¹⁷ EIA, "Monthly Biodiesel Production Report," September 2013, accessed October 4, 2013, <http://www.eia.gov/biofuels/biodiesel/production/biodiesel.pdf>.

consumption is expected to rise steadily for beef, pork, and poultry through 2018. As shown in Exhibit 47 below, the average U.S. resident will consume 200 pounds in 2013 and 206.6 pounds in 2018.²¹⁸

Exhibit 47: U.S. per-capita meat consumption

Calendar year	2011	2012	2013	2014	2015	2016	2017	2018
	(Pounds)							
Beef	57.3	57.4	56.1	54.2	54.0	54.4	55.1	55.7
Pork	45.7	45.9	46.9	47.6	48.5	49.1	49.1	48.5
Broiler	82.9	80.4	81.2	83.6	85.1	85.5	85.5	85.7
Turkey	16.1	16.0	16.2	16.4	16.8	16.8	16.8	16.7
Sum	202.0	199.7	200.4	201.9	204.4	205.8	206.4	206.6

Source: Food and Agricultural Policy Research Institute, 2013.²¹⁹

Additionally, investments in technologies and techniques to reclaim or capture animal fats and recycled oils from waste streams may also help to increase the availability of feedstocks. However, much like other agricultural markets, the opportunity to expand the use of fats and oils will continue to be based on the value of the commodity. Other competing uses for animal fats and recycled oils and demand for lipids from foreign markets will continue to present financial challenges for the use of these feedstocks in domestic biofuel production.

8.2 Production Capacity

Many biodiesel plants are currently operating at partial capacity corresponding with existing demand. In June 2013, the U.S. biodiesel industry produced a record level of 113 million gallons, from 116 reporting active biodiesel plants.²²⁰ The same month, EIA reported the national biodiesel production capacity to be approximately 180 million gallons a month,²²¹ allowing for additional production of fuel if demand were to increase.

Through a combination of factors, including mandates, tax incentives, market price, and environmental concerns, biomass-based diesel use is predicted to expand. DOE predicts biodiesel demand will double by 2030,²²² and the EPA estimates a monthly demand of approximately 139 million gallons in 2022.²²³ This projected demand is driving much of the investment in new production plants even though existing facilities are not producing at the maximum capacity.

²¹⁸ FAPRI, "August 2013 Baseline Update for U.S. Agricultural Markets," pg. 13, August 2013, accessed October 4, 2013, http://www.fapri.missouri.edu/outreach/publications/2013/FAPRI_MU_Report_04_13.pdf.

²¹⁹ FAPRI, "August 2013 Baseline Update for U.S. Agricultural Markets," pg. 13, August 2013, accessed October 4, 2013, http://www.fapri.missouri.edu/outreach/publications/2013/FAPRI_MU_Report_04_13.pdf.

²²⁰ EIA, "Monthly Biodiesel Production Report," August 29, 2013, accessed September 2013, <http://www.eia.gov/biofuels/biodiesel/production/>.

²²¹ Ibid.

²²² U.S. Department of Energy, "U.S. Billion-Ton Update: Biomass Supply for a Bioenergy and Bioproducts Industry," August 2011, accessed August 2013, http://www1.eere.energy.gov/bioenergy/pdfs/billion_ton_update.pdf

²²³ EPA, "Renewable Fuel Standard Program Regulatory Impact Analysis," February 2010, pg. 190, accessed August 2013, <http://www.epa.gov/otaq/renewablefuels/420r10006.pdf>.

8.2.1 Future Production Sites

As biodiesel consumption increases, other sites around the country are being evaluated for new biomass-based diesel production facilities. As with traditional petroleum refineries, specific criteria are used to determine site suitability. Ideally, most production facilities are located close to a feedstock supply, finished product demand, skilled workforce, and infrastructure availability. Biorefineries are rarely located in the same area as supply and demand centers. Determining the cost feasibility of shipping the fuel and feedstock is the first step in determining site location.

Once the general area of a biomass-based diesel refinery is determined, certain criteria are used to refine the location. Land availability and cost, size of an existing building, and inexpensive transportation options – proximity to interstates and rail access – are the main criteria. Next, developers review the permitting and regulatory restrictions of the area and public support for new industrial developments. Zoning regulations, health and safety regulations, and utility access and costs are also considered. Furthermore, developers consider state and local incentives such as tax credits, grants, or low-interest financing.

8.2.2 Future Production Supply

Biomass-based fuels are being evaluated to determine how significant of a role they will have in the future energy supply. In 2013, DOE completed a study on “Projected Biomass Utilization for Fuels and Power in a Mature Market” as part of the *Transportation Energy Future Series*. This report found that biomass-based fuel consumption will increase, successfully competing against traditional petroleum fuels for vehicles and aviation sectors, particularly if the U.S. adopts a carbon capture and sequestration policy. The study notes however that the supply sources of current feedstock will be constrained by the available resources.²²⁴ For these reasons, the United States government is investing heavily into research, development, and commercialization of new feedstock supply. DOE’s goal is to have drop-in biofuels be cost competitive at \$3/gallon without tax incentives by 2017. New technologies, production efficiencies, and feedstock advancements will expand the biomass-based diesel portfolio to prevent future supply disruptions as discussed in the following section.

8.3 Technological Advancements

8.3.1 Technological and Production Efficiency Advancements

New technologies and production efficiencies may provide a more efficient use of current feedstocks, allowing for more biomass-based diesel production even if feedstocks developments are limited. Technological advancements are cutting cost, waste, and time out of the production process. These technologies begin in the field, in equipment used to plant and grow feedstocks, allowing for a more oil enriched feedstock to be grown with less water, energy, and fertilizer. Some of these feedstocks are even being genetically modified to produce more oil for fuels. Harvesting technologies are also being enhanced, to minimize the time and cost to move feedstocks from the fields to the processing plants.

²²⁴ U.S. Department of Energy, “Transportation Energy Future Series: Projected Biomass Utilization for Fuels and Power in a Mature Market”, March 2013, accessed August 2013, <http://www.nrel.gov/docs/fy13osti/53336.pdf>.

Over the last several decades the U.S. researchers have investigated methods to improve biodiesel production efficiencies. These methods include, but are not limited to, temperature control, type and concentration of catalyst, viscosity, acid value, presence of chemical elements such as iron, magnesium, calcium, etc., alcohol to oil ratio, and feedstock source. In 2013, DOE invested \$13 million in new technologies to continue research in these advancements. The grants went to projects to deoxygenate bio-oil, remove hydrogen from bio-oil with microbial electrolysis, enhance the mechanical process to remove oil from biomass, and increase carbon conversion efficiency in biomass. All of these processes currently exist in biofuel production facilities, yet can be streamlined to make fuel more cost-competitive.²²⁵

One of the methods that have been technically proven to produce biodiesel more efficiently than traditional methods is the Multi-Energy Optimization Process. This process combines microwaves and ultrasound waves and results in a complete emulsification wherein equal sized droplets of oil and catalyst are uniformly distributed and heated at the point of reaction. To produce one gallon of biodiesel, this method utilizes approximately 50 percent of the energy required by traditional means. Additionally, only 40 percent of the catalyst is consumed. Overall, this technology reduces capital and energy costs, maximizes labor costs, and increases output.²²⁶

Another production enhancement technology are fuel additives. Fuel additives increase biodiesel stability and operability by averting oxidation and thermal degradation of produced biodiesel. Components that can cause this instability and inoperability include, but are not limited to, formation of insolubles, oxidation or degradation of glycerols produced during transesterification, corrosion by free fatty acids, and oxidation and polymerization catalyzed by metals. Fuel additives have been technically proven to avert and regulate oxidation and polymerization reactions and peroxide formation, to impede metal catalysis, and counteract acids that can catalyze polymerization reactions.²²⁷

Brown grease is making some of the most transformative advances in on-site processing capabilities, with several new technologies currently in the testing and demonstration phase. As discussed in Section 2.1.2.2.2., the grease is separated in sewage treatment plants. Brown grease, when separated from sewage, still contains water in the mixture, requiring that these units separate the oil and water before converting the fuel to biodiesel. Once separated, the grease can then be converted to fuel on-site with these technologies. This next generation of brown grease processing would potentially save New York City from transporting the nearly 20,000 gallons of brown grease collected weekly from NYC wastewater treatment plants to landfills. This would reduce over one million gallons of waste grease from going to the landfills each year. Fuel could instead be created onsite at these plants, and used to power other equipment on-site. This would save NYC a significant amount of money each year by not having to pay for grease hauling to landfill, and not having to purchase diesel fuel to run equipment on-site.

²²⁵ U.S. Department of Energy, "Energy Department Announces Investment to Accelerate Next Generation Biofuels", U.S. Department of Energy Press Release, July 1, 2013, accessed August 2013, http://apps1.eere.energy.gov/news/news_detail.cfm/news_id=19404.

²²⁶ Biodiesel Magazine, "Reducing Cost While Increasing Output," October 2011, accessed October 2013, <http://www.biodieselmagazine.com/articles/8119/reducing-cost-while-increasing-output>.

²²⁷ Biodiesel Magazine, "Improving Biodiesel Stability with Fuel Additives," January 2007, accessed October 2013, <http://www.biodieselmagazine.com/articles/1443/improving-biodiesel-stability-with-fuel-additives>.

8.3.2 New Feedstock Sources

As discussed previously, there are numerous types of feedstocks already in production and new sources are expected. When faced with increased shortage of acreage to produce fuel on land, producing fuel in water is the next alternative for expansion. Algae oil, though not commercially produced, is universally considered the next breakthrough biomass-based diesel feedstock. Currently being studied and tested extensively around the world, algae has been found growing in places where there is no other competition for the water usage – including sewage treatment ponds, mine tailings ponds, and other polluted bodies of water. In fact, in these locations algae growth aids in the water remediation. In August 2013, the Department of Energy announced plans to invest an additional \$16.5 million in algae biofuels development, with the goal of having cost-competitive algae biofuels in the market by 2022.²²⁸ This corresponds with their investment in April 2013 in a pilot-scale biorefinery in Iowa to process algae fuels into biodiesel for the military²²⁹. There are two types of algae that are being researched as potential feedstocks – autotrophic and heterotrophic algae. The UK Marine Conservation Society describes autotrophic algae as algae that can photosynthesize and grow using dissolved inorganic nutrients and heterotrophic algae as algae that capture organic molecules as a primary source of nutrition.²³⁰ Current research shows that heterotrophic algae yield 3.4 times more oil (with an acetane rate of 74) than autotrophic algae. Additional research also shows that the reaction rate can be increased to 99 percent using catalysts such as calcium oxide nanocrystals.²³¹

Cyanobacteria is another feedstock currently being tested, which also grows in water. In 2012, NREL published a study wherein they found a way to alter the photosynthesis process of cyanobacteria to produce more oils in the bacteria.²³² In 2009, NREL commenced researching the possibility of engineering the natural photosynthesis process of cyanobacteria such that it resulted in an increase in the production of lipids. Although the results of the research directed towards cyanobacteria are uneconomic for biodiesel production, an unexpected finding also occurred. NREL researchers discovered that by altering the conditions of the photosynthesis, the mutant cyanobacteria resulted in the production of a large quantity of organic acids. With this breakthrough, NREL continues to research the potential large-scale production of organic acids from the mutant cyanobacteria and the conversion of those organic acids to biofuels and chemicals.²³²

The process of producing synthetic diesel using cellulosic feedstocks and municipal solid waste through the Fischer-Tropsch (FT) process is also being researched. FT is a thermo-chemical process, wherein solid feedstocks like woody biomass or coal are gasified to produce liquid fuels along with carbon monoxide and hydrogen. During the process, synthetic gas is produced, cleaned, and undergoes FT to

²²⁸ U.S. Department of Energy, “Secretary Moniz Announces New Biofuels Projects to Drive Cost Reductions, Technological Breakthroughs”, U.S. Department of Energy Press Release, August 1, 2013, accessed August 2013, <http://energy.gov/articles/secretary-moniz-announces-new-biofuels-projects-drive-cost-reductions-technological>.

²²⁹ U.S. Department of Energy, “Energy Department Announces New Innovative Projects to Develop Advanced Drop-In Biofuels for Military Jets and Ships”, U.S. Department of Energy Press Release, April 22, 2013, accessed August 2013, <http://energy.gov/articles/energy-department-announces-new-innovative-projects-develop-advanced-drop-biofuels-military>.

²³⁰ Marine Conservation Society (UK) Southeast – Marine Biology Glossary, accessed October 2013, <http://www.marine-conservation.org.uk/marine%20biology%20glossary.html#anchor364254>

²³¹ Satapathy S (2013), “A New Dimension to Algae Fuel: Far from Light and Closer to Human Needs.” 2: 671.

doi:10.4172/scientificreports.671, 2013, accessed online <http://www.omicsonline.org/scientific-reports/2155-952X-SR-671.pdf>

²³² National Renewable Energy Laboratory, “NREL Creates New Pathways for Producing Biofuels and Acids from Cyanobacteria”, October 2012, accessed August 2013, <http://www.nrel.gov/docs/fy13osti/55974.pdf>.

produce a range of liquid fuels. Even though FT is commercially available today in coal-to-liquid processing, its use in the synthetic diesel industry has a few challenges. These challenges include the gasification of biomass, production of clean gas of acceptable quality, and cost of production. Research is also underway to develop catalysts that have a higher lifetime, activity, and selectivity for use in FT.²³³

8.4 Potential Competition for Biomass-Based Diesels

California's Low Carbon Fuel Standard (LCFS) requires a 10 percent reduction in the carbon intensity of transportation fuels. ICF analysis indicates that there are significant carbon reduction opportunities through biodiesel consumption in California. For instance, in the report that ICF prepared for a multi-stakeholder group,²³⁴ the compliance scenarios indicate that biodiesel consumption will increase to levels of about B15 (representing a mix between B5 and B20). This translates to 300-400 million gallons of biodiesel consumption annually in California by 2020, up from levels of around 25 million gallons in 2011. California's in-state capacity is currently running at utilization rates of about 40-45 percent, producing volumes of 25-26 million gallons. Even with the addition of 1-2 production facilities over the next several years, it is likely that the balance of biodiesel will be imported to California from other states.

Biodiesel production facilities in the rest of the United States have been utilized at rates of about 45-50 percent over the last several years,²³⁵ the balance of biodiesel that is forecasted to be consumed in California in 2020 will not pose a supply risk to other parts of the country. Even in a worst case scenario – where the biodiesel consumption in California is entirely marginal or additional production, rather than the result of shifting consumption from one region to another – the increased consumption of biodiesel in California is unlikely to pose a supply risk to other regions in the United States.

Other states – including Washington and Oregon – have considered similar LCFS regulations. Oregon adopted Phase 1 of a LCFS in 2009 via House Bill 2186 (HB 2186).²³⁶ However, in July 2013, Oregon's State Senate rejected a measure that would have removed the sunset provisions in HB 2186. The Senate may reconsider the measure in the future. Washington is considering climate change programs, including a LCFS program (amongst a variety of other options). It is unclear at this time if a LCFS will emerge as part of the technical analyses being presented to Washington's Climate Legislative and Executive Workgroups. Regardless, if either Oregon or Washington ultimately implement a LCFS program, the biodiesel impacts are likely small.

Northeast States for Coordinated Air Use Management (NESCAUM) has developed an outline of a Clean Fuels Program for the region, including a regional economic and environmental impact analysis.²³⁷ If a Clean Fuels Program moves forward in the region, it will most certainly increase biodiesel consumption; however, it is unclear to what extent. The biodiesel consumed in NYC would count towards compliance

²³³ International Energy Agency – Bioenergy, "From 1st To 2nd Generation Biofuels Technologies – An Overview of Current Industry and RD&D activities", November 2008, accessed October 2013, http://www.iea.org/publications/freepublications/publication/2nd_Biofuel_Gen.pdf

²³⁴ ICF International, "California's Low Carbon Fuel Standard: Compliance Outlook for 2020," June 2013, accessed October 2013, <http://www.caletc.com/wp-content/downloads/LCFSReportJune.pdf>

²³⁵ EIA, "Monthly Biodiesel Production Report," September 2013, accessed October 2013, <http://www.eia.gov/biofuels/biodiesel/production/table1.pdf>

²³⁶ Oregon Legislative Assembly, House Bill 2186, Section 3(1)(a), 2009 Session, accessed October 2013, <http://www.leg.state.or.us/09reg/measpdf/hb2100.dir/hb2186.intro.pdf>

²³⁷ More information available online at: <http://www.nescaum.org/topics/clean-fuels-standard>

with the regional program, so it is unlikely that there would be supply risks to NYC. This type of regulation would actually provide some counter-demand to Western states (e.g., California, Washington, and Oregon) via similar price premiums (through a valuation of carbon reductions) and ensure that biodiesel production in the Northeast, the Southeast, and to some extent the Midwest would be consumed on the East Coast.

Some states require a certain blend percent of biodiesel:

- Minnesota, for instance, currently requires a 5 percent blend of biodiesel. The state was originally set to increase to a rate of 10 percent in 2012 and a B20 blend in 2015; however, the transition to B10 was delayed for a variety of reasons²³⁸ before being approved recently.²³⁹ As part of the transition to higher blends, Minnesota conducts an assessment of federal standards for blend specifications, the production capacity of biodiesel in Minnesota, the in-state blending capabilities, and the source of the feedstocks. This market assessment built into the legislation demonstrates the control mechanisms in place to limit shocks to Minnesota's market (e.g., limited blending availability in certain parts of the state would lead to volatility). It also provides a buffer to other regions in terms of supply risk.
- Pennsylvania currently requires a 2 percent biodiesel blend, with the blend rate scheduled to increase according to in-state biodiesel production. The mandated blending rate will increase to B5 if Pennsylvania's in-state production reaches 100 million gallons. Over the last year, there have been 4-6 facilities online capable of producing 85-91 million gallons annually in Pennsylvania. It seems then that Pennsylvania is likely to increase its biodiesel blending mandate to B5 in the near-term future (2-5 years). The revised blend requirement would increase in-state consumption from about 30 million gallons to 80 million gallons of biodiesel annually.

ICF research indicates that the majority of biodiesel delivered to NYC is supplied by production facilities in the Midwest and near the Gulf Coast [link to Sec 4.1]. Based on this research, it is unlikely that the potential increase in biodiesel consumption in states such as Minnesota or Pennsylvania due to blending mandates will yield a supply constraint to NYC.

The Department of Defense (DoD) accounts for about 80 percent of the federal government's energy consumption; and 70 percent of DoD's energy consumption is from petroleum-based fuels. Of that, jet fuel represents about 70 percent and ground vehicles account for about 15 percent.²⁴⁰ Biodiesel cannot be blended with jet fuel; therefore, the DoD has a limited capacity to blend biodiesel given that on-road vehicles and diesel equipment make up a modest portion of its fuel consumption. The DoD has very specific fuel requirements for alternative fuels, requiring that they must have a "drop-in" capability, meaning that they can be integrated into the existing infrastructure without operational drawbacks. Biodiesel can generally fulfill some of, but not all of these requirements. Biodiesel has sufficient energy density – it contains only 6 percent less energy per barrel than conventional diesel; however, there are

²³⁸ Minnesota Department of Agriculture, "Report to Legislature: Annual Report on Biodiesel," January 2012, accessed October 2013, <http://www.mda.state.mn.us/news/government/~media/Files/news/govrelations/legprpt-biodiesel2012.ashx>.

²³⁹ Minnesota State Register, Vol. 38, No 14, Monday September 30, 2013, p445, accessed October 2013, http://www.comm.media.state.mn.us/bookstore/stateregister/38_14.pdf.

²⁴⁰ Congressional Research Service, "Department of Defense Energy Initiatives: Background and Issues for Congress," December 2012, accessed October 2013, <http://www.fas.org/sqp/crs/natsec/R42558.pdf>.

limitations to the “drop-in” capabilities of biodiesel. As a result, the DoD has focused on what are considered advanced biofuels, also referred to as renewable diesel or renewable jet fuel.

The blending of biodiesel has been one of the more successful aspects of the federal Renewable Fuel Standard (referred to as RFS2) – which requires a certain volume of biofuels to be blended into conventional transportation fuels. The biodiesel target has been met and surpassed in each of the last several years. Given the delays in the available volumes of other renewable fuels included in the legislation – specifically cellulosic biofuels – it is likely that the RFS2 will continue to increase the target for biodiesel moving forward. This will continue to send a strong policy signal to the biodiesel industry and ensure that production capacity is managed tightly. ICF believes that the success of the biodiesel industry in achieving the volumetric targets under the RFS2 will lead to increased targets, thereby increasing supply. In other words, the RFS2 will likely help minimize the risk of supply shortages to areas like New York City.

Appendix

Appendix 1: List of Acronyms and Definitions

\$/gallon	Dollars per gallon
1D	The symbol 1D shall be used as a grade designation for light distillate diesel fuel oils used in vehicular diesel engines and in higher volatility applications than provided by grade 2D fuel oils.
2D	The symbol 2D shall be used as a grade designation for middle distillate diesel fuel oils used in vehicular diesel engines and in non-vehicular applications having frequently varying loads and speeds.
AEO	The U.S. Energy Information Administration’s (EIA) <i>Annual Energy Outlook</i> , which details the EIA’s expectations for the U.S. energy sector. The current AEO, released in April 2012, includes projections through 2035.
ARRA	American Recovery and Reinvestment Act
ASTM	The acronym, “ASTM” shall be used as a designation for the American Society of Testing and Materials.
B2, B5, B20	Biodiesel 2 percent, Biodiesel 5 percent, Biodiesel 20 percent Diesel composed of a certain proportion of biomass (e.g., vegetable oil or animal fat) and the remaining proportion petroleum diesel. B2 indicates biodiesel proportions of 2 percent biodiesel and 98 percent petroleum diesel, while B5 has 5 percent biodiesel, and B20 has 20 percent biodiesel, and the remainder petroleum diesel.
B/d	Barrels per Day
bbbl	Barrel
Biodiesel	Biodiesel means a renewable, biodegradable, mono-alkyl ester combustible liquid fuel processed from agricultural vegetable oils or animal fats that meets ASTM D6751 for biodiesel fuel blend stock for distillate fuel. Referred to throughout as a biodiesel blend (see B2, B5, and B20).
BOE	Barrels of Oil Equivalent
Bioheat	The utilization of ASTM certified biodiesel within No. 2, 4, and 6 heating oils. Bioheat can include any blend of biodiesel with heating oil.

Blendstocks	Motor gasoline blending components that are to be blended with oxygenates to produce finished gasoline. This can also refer to foreign gasoline that does not meet U.S. specifications and must be blended or re-refined to be sold in the United States.
Btu	British Thermal Units. Unit of measure for energy content of fuels (rather than volume content measures, such as barrel or gallon).
CPG	Cents per Gallon
DEC	New York State Department of Environmental Conservation
DFO	Distillate Fuel Oil, or No. 2 Fuel
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EIA	U.S. Energy Information Administration
EISA	Energy Independence and Security Act
EPA	U.S. Environmental Protection Agency
MMBtu	Million Btus
MMg/y	Million Gallons per Year
IEA	International Energy Agency
Mbbl	Thousand Barrels
MMbbl	Million Barrels
Mb/d	Thousand Barrels per Day
MMb/d	Million Barrels per Day
MMg/y	Million Gallons per Year
mpg	Miles per Gallon
MT	Metric Tons

NAICS	North American Industry Classification System. NAICS codes are the standard used by federal statistical agencies for classifying business establishments' data for the purpose of gathering, analyzing, and publishing U.S. economic trends.
NHTSA	National Highway Traffic Safety Administration, part of the U.S. Department of Transportation
NYH	New York Harbor, which represents a conglomeration of water-access distribution terminals primarily in northern New Jersey, pipeline distribution hubs in northern New Jersey, and local terminals in New York City and Long Island.
NYMEX	New York Mercantile Exchange
NYS	New York State
NYSERDA	New York State Energy Research and Development Authority
OPEC	Organization of Petroleum Exporting Countries
PADD	Petroleum Administration for Defense (PAD) Districts. The U.S. was divided into five PADDs during World War II to organize fuel allocation throughout the country, though these regional allocations are used today for data collection purposes only. PADD I (East Coast): New England, Middle Atlantic (including New York State), and Lower Atlantic; PADD II: Midwest; PADD III: Gulf Coast; PADD IV: Rocky Mountain; and PADD V: West Coast, Alaska, and Hawaii.
PPM	Parts per Million
QBtu	Quadrillion British Thermal Units
RIN	Renewable Identification Number. This is the basic currency for the Renewable Fuels Standard program for credits, trading, and use by obligated parties (e.g., petroleum refineries, petroleum bulk stations and terminals, petroleum merchant wholesales) and renewable fuel exporters to demonstrate compliance, as well as track the volumes of renewable fuels. A RIN is a 38-character numeric code that is generated by the producer or importer of renewable fuel and assigned to batches which are transferred through a change of ownership. RINs are valid for the calendar-generated year, or the following year, depending on the time RIN is obtained.
RBOB	Reformulated Blendstock for Oxygenate Blending
RFS	Renewable Fuels Standard.

RFS1: Renewable Fuel Standard under EPAct 2005 – The Energy Policy Act of 2005 (EPAct 2005) established the Renewable Fuel Standard, which required obligated parties to blend conventional fuels with a pre-determined minimum volume of renewable fuels.

RFS2: Renewable Fuel Standard as amended by the Energy Independence and Security Act (EISA) amended RFS1 in December 2007. The revised standard created by this amendment is commonly referred to as RFS2. RFS2 increased the RFS1 volume requirements for renewable fuels to be blended with conventional fuels. RFS2 also created four categories of fuel (cellulosic biofuels, biomass-based diesel, advanced biofuels, and renewable fuels) and requires specific volumes for each category each year through 2022.

ULSD	The acronym ULSD shall be used as a grade designation for ultra low sulfur diesel fuel that has a sulfur content of not more than 15 parts per million (15 ppm).
USD	U.S. Dollar
USDA	U.S. Department of Agriculture

Appendix 2: Case Study: NYC Biodiesel Initiatives

The City of New York has been using biodiesel in its fleet since 2005, leading by example and encouraging other fleets to do the same. The City has one of the largest municipal fleets in the country with 26,000 vehicles, of which approximately 25 percent use alternative transportation fuels and technologies, including biodiesel, natural gas, electric vehicles and hybrids.²⁴¹ The City also purchases 75 million gallons of fuel annually, making it one of the largest private fuel buyers in the New York City (NYC) area.²⁴² Biodiesel blends are currently used in 6,100 of 9,074 diesel units (approximately 68 percent). Additionally, the City has successfully combined biodiesel fuel with other advanced vehicle and emission reduction technologies, such as hybrid diesel electric and idle reduction units.

New York City's Biodiesel History

In September 2013 the City began the full implementation of the biodiesel fleet plan by enacting Introductory Bill 1061-A-2013, requiring the use of B5 in all diesel vehicles and equipment year-round. In 2016 all diesel vehicles will be required to use B20 (blend of 20 percent biodiesel and 80 percent diesel) from April through November. A pilot study to examine the feasibility of year-round B20 fuel is also underway.²⁴³ The City is now on track to use more than 5 million gallons of biodiesel in fleet units in fiscal year (FY) 2013 with a total of 70 percent of all diesel fuel containing some level of biodiesel as shown in the table below.²⁴⁴ Biodiesel use by agency is captured below:

NYC Total Biodiesel Consumption by Agency (in gallons), FY12-FY13

Agency	Biodiesel		Total Diesel		% Biodiesel	
	FY12	FY13*	FY12	FY13*	FY12	FY13*
Correction	47,857	115,934	294,183	115,934	16%	100%
Environmental Protection	214,463	131,703	308,028	134,275	70%	98%
Fire	0	0	3,231,986	1,474,011	0%	0%
Parks	540,187	312,954	595,926	312,954	91%	100%
Police	0	0	360,020	292,042	0%	0%
Sanitation	7,989,001	4,151,491	8,628,557	4,160,794	93%	100%
Transportation	466,634	255,778	1,273,454	614,546	37%	42%
Citywide	9,258,142	4,967,860	14,692,154	7,104,556	63%	70%

Source: Department of Citywide Administrative Services, 2012.²⁴⁵

*FY13 projections

²⁴¹ City of New York, "PlanNYC," April 2011, pg. 125, accessed June 2013,

http://nytelecom.vo.llnwd.net/o15/agencies/planyc2030/pdf/planyc_2011_planyc_full_report.pdf.

²⁴² Iowa Farmer Today, "Iowa Biodiesel Turning Heads in New York City," February 3, 2012, accessed June 2013,

http://www.iowafarmertoday.com/news/regional/iowa-biodiesel-turning-heads-in-new-york-city/article_230b3fae-4dc7-11e1-8da3-001871e3ce6c.html.

²⁴³ City of New York, "Mayor Bloomberg signs legislation promoting fuel efficiency, cleaner fuel and upgraded engines in the city's fleet of vehicles," City of New York press release, September 4, 2013.

²⁴⁴ Department of Citywide Administrative Services, "NYC Fleet: Biodiesel Use in Fleets," PowerPoint Presentation, December 12, 2012.

²⁴⁵ Department of Citywide Administrative Services, "NYC Fleet: Biodiesel Use in Fleets," PowerPoint Presentation, December 12, 2012. Fiscal year is from July through June.

Using Municipal Equipment to meet Citywide Emissions Reduction Goals

In 2011, the City committed to expanding the use of biodiesel in its fleet as part of the PlaNYC greenhouse gas (GHG) emission reductions goals.²⁴⁶ As a subset of the PlanNYC goal, the City established a municipal GHG emission reduction target of 30 percent by 2017 from 2006 emissions base levels from municipal operations, including fleets and improvements to the City’s existing buildings.

“First at Parks, and now for the entire City fleet, we have introduced biodiesel as one part of a comprehensive strategy to reduce tailpipe and greenhouse gas emissions. Biodiesel is a domestic and renewable fuel, has been effectively cost neutral, and we have implemented it with very few upfront costs or maintenance concerns,” said Keith Kerman, Chief Fleet Officer of the City of New York²⁴⁷.

The City considers biodiesel to be a carbon-neutral fuel; although the fuel releases carbon dioxide when burned, the plants used to produce the biodiesel consume carbon dioxide to grow. Additionally, B20 can reduce particulate matter emissions by 10 percent and unburned hydrocarbons by 21 percent.²⁴⁸

Department of Sanitation

The Department of Sanitation (DSNY) has the largest municipal refuse fleet in the country, with 4,000 diesel vehicles, including diesel garbage trucks (which double as snow plows in the winter), dump trucks, and salt spreaders.²⁴⁹ In 2007, DSNY began using B5 in approximately 40 vehicles. After verifying the fuel performance, DSNY integrated B5 into the entire fleet. The same year, DSNY also initiated a B20 pilot project with vehicles in the Queens 6 District, which was expanding to include the Brooklyn 5 district in July 2010. Collectively, the pilot project resulted in no negative impacts.²⁵⁰ DSNY is piloting citywide use of B20 from April through November 2013 and has not experienced any problems to date.



A Sanitation Department hybrid hydraulic garbage truck also operates on B20.
– Photo courtesy of New York City

Initially, DSNY fleet engine manufacturers, Cummins and Mack, expressed concern about maintaining vehicle warranties with B20 blends. The manufacturers eventually agreed to provide warranties for blends up to B20 as part of the five-year engine warranty package.²⁵¹

²⁴⁶ City of New York, “PlanNYC,” April 2011, pg. 125, accessed June 2013, http://nytelecom.vo.llnwd.net/o15/agencies/planyc2030/pdf/planyc_2011_planyc_full_report.pdf.

²⁴⁷ Keith Kerman, Chief Fleet Officer of the City of New York, Email to author, September 14, 2013.

²⁴⁸ AFDC, “Biodiesel Benefits and Considerations,” accessed June 2013, http://www.afdc.energy.gov/fuels/biodiesel_benefits.html.

²⁴⁹ National Biodiesel Board, “New York City Sanitation Department,” accessed June 2013, <http://www.biodiesel.org/using-biodiesel/market-segments/fleets>.

²⁵⁰ City of New York Department of Sanitation, “2010 Annual Report on Alternative Fuel Vehicle Programs Pursuant to Local Law 38 of 2005,” May 2011, accessed August 2013, http://www.nyc.gov/html/dsny/downloads/pdf/pubinfo/annual/Hybrid/2010LL38%20Report_2011FINAL.pdf.

²⁵¹ Interview with Rocky DiRico, Sanitation Department, April 1, 2013. At the time of the interview, the warranty package only applied to DSNY equipment.

DSNY stores approximately 25 percent of the equipment outdoors and has not had any problems despite initial concerns about the fuel gelling in cold weather. Gelling occurs if a fuel has a higher cloud point, which is measured by the temperature at which solids begin to form in the fuel, creating a cloudy appearance. If solids do form in the fuel it can impede proper diesel flow in the fuel lines and plugs fuels filters.

Currently, the building maintenance division is responsible for transitioning City owned refueling locations and underground storage tanks to use biodiesel blends. Facility operators use standard operating procedures for tank maintenance and preparation has been minimal to date.²⁵²

Parks and Recreation Department

The Parks and Recreation Department operates over 850 medium- and heavy-duty vehicles and other diesel equipment units. The agency has piloted the use of biodiesel blends up to B100 in equipment including three cylinder engines, V8 diesel engines, and six cylinder turbodiesels.²⁵³ The Parks and Recreation equipment inventory spans well over 30 years in age, includes products from 57 different manufacturers, and consists of dump trucks, packers, air compressors, backhoes, ballfield rakes, beach tractors, boom trucks, buses, carts, chippers, dredgers, extractors, forklifts, generators, leaf vacuums, light towers, mini-packers, pick-ups, stump cutters, sprayers, sweepers, tractors, trailers, tree trimmers, vans, water trucks, wreckers, and other units.²⁵⁴ Parks and Recreation also uses bioheat in all of its 153 buildings. A total of 182 heating oil tanks have used B5 to B20 blends since 2007.²⁵⁵ In 2013, Parks and Recreation performed a B50 pilot project at Orchard Beach in the Bronx and the entire Staten Island diesel fleet.

In FY06, Parks and Recreation dispensed 561,700 gallons of diesel fuel at a cost of \$1.24 million – an average cost of \$2.20/gallon – used at 10 different fueling locations.²⁵⁶ Since then, Parks and Recreation has used an increasing amount of biodiesel and has seen a fuel cost reduction since a spending peak in FY08 as shown below.

²⁵² Ibid.

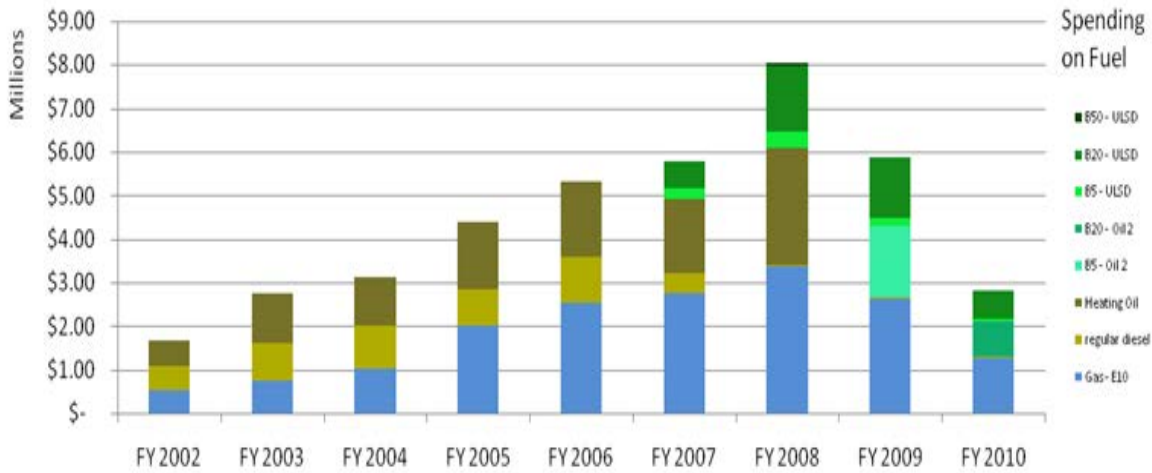
²⁵³ Keith Kerman, City of New York Parks & Recreation, "Report on the Use of Biodiesel and Ultra Low Sulfur Diesel for Parks Diesel Trucks and Equipment Citywide," June 19, 2007, p. 2.

²⁵⁴ Ibid, p. 2-6.

²⁵⁵ Department of Parks and Recreation, "Parks Honored for Use of Biodiesel Technologies," The Daily Plant, Volume XXV, Number 5359, March 1, 2011, <http://www.nycgovparks.org/news/daily-plant?id=22368>.

²⁵⁶ Ibid, p. 6.

Department of Parks and Recreation Fuel Spending, FY2002-FY2010



Source: Department of Parks and Recreation, 2010.²⁵⁷

In 2011, the agency was recognized by the National Biodiesel Board for its progressive use of biodiesel. The agency had used over 4.5 million gallons of biodiesel.²⁵⁸ Currently, all diesel fleet and equipment units at Parks and Recreation use B20, with an interest in increasing the blends in the future.

Biodiesel Performance Issues

The City has had a few reported incidents since using the fuel in 2005. For example, in 2006 four Parks and Recreation vehicles in the Bronx reportedly stalled due to gelling issues during a cold weather event. The vehicles were warmed up in the garage and were only delayed by an hour. Parks and Recreation remains uncertain whether the issue was related to B20 or water in the fuel dispensing equipment.²⁵⁹ Additionally, biodiesel used in some Parks and Recreation utility transportation vehicles initially caused clogging in several of the fuel filters, which required standard filter replacements.

Fuel Requirements

The City of New York uses municipal fueling facilities, which now dispense a minimum of B5. To ensure all fuel is safe and reliable, the City has very strict biodiesel fuel quality requirements. All biodiesel must be produced at BQ-9000® certified facilities to ensure the producers or marketers comply with industry best practices. The City’s fuel contracts also require biodiesel to be certified to the most recent ASTM D6751 standard for B100 and ASTM D7467 for blends between B6 to B20.²⁶⁰ The blended fuel must also conform with existing U.S. Environmental Protection Agency (EPA) provisions for Title II of the Clean Air Act, section 211, and regulations at 40 C.F.R. Parts 79 and 80 (or the latest version).

²⁵⁷ NYC Parks & Recreation, “Greening the Parks Fleet,” PowerPoint Presentation, April 22, 2010.

²⁵⁸ National Biodiesel Board, “New York City Sanitation Department,” <http://www.biodiesel.org/using-biodiesel/market-segments/fleets>.

²⁵⁹ Keith Kerman, Department of Parks and Recreation, “Report on the Use of Biodiesel and Ultra Low Sulfur Diesel for Parks Diesel Trucks and Equipment Citywide,” June 19, 2007, pp. 10-11.

²⁶⁰ Department of Citywide Administrative Services, Division of Municipal Supply Services, “Specification for Biodiesel B5 and B6 to B20 (on road use only),” Specification #16-F-5:10A, p. 1.



This Parks and Recreation Department hybrid diesel electric rack truck operates on B20.
 – Photo courtesv of New York Citv

Based on the stringent fuel quality procurement standards, most of the fuel used by the City is produced from virgin soy oils, which contain relatively little glycerin (i.e., soap) prior to the biodiesel production process. This type of feedstock operates better in colder temperatures because it has a lower cloud point and is less likely to have gelling issues.

Conclusion

The City of New York is a national municipal leader in biodiesel consumption. From individual City fleet and heating oil initiatives, to the new citywide biodiesel mandate, the City has made significant strides to reduce diesel emissions. Biodiesel has been a cost-

effective alternative, which required minimal modifications of existing fleet vehicles and heating oil equipment. The City of New York is setting a standard for other municipalities and sharing valuable lessons learned with other communities.

Appendix 3: Case Study: Bioheat

The next generation of heating oil has arrived in New York City (NYC). Bioheat™,²⁶¹ the combination of biodiesel and traditional heating oil, is being utilized as a clean fuel alternative to reduce emissions. The historic buildings and infrastructure that define NYC create numerous logistical and technical issues when trying to upgrade or modify the heating infrastructure used throughout the city. In addition to creating significant greenhouse gas emissions during winter months, heating oil also contributes to poor air quality in and around NYC. In 2010, the NYC City Council enacted Introductory Bill 0194-2010 requiring the use of clean heating oil fuels and creating the NYC Clean Heat program. Beginning in 2012, biodiesel must comprise 2 percent or more of all heating oil grades available in NYC.²⁶²

Clean Heat Program Fuel Options

The Clean Heat program assists the buildings that need to comply with the NYC Department of Environmental Protection regulation that phases out No. 6 and No. 4 heating oils, which can emit visual pollution from buildings. The limitations of New York City heating infrastructure and high project costs mean that natural gas is not available to all system permits when they need to be renewed. Natural gas is not accessible for much of NYC and connections to Con Edison's steam lines are limited. There is an increased cost burden as well when switching to these fuels, as entire heating systems may need to be replaced and chimney's need to be lined. Renewable energy alternatives, such as solar thermal panels, geothermal heat pumps, and co-generation are all available options, but have a higher installation cost and often must be combined with traditional fuel sources to meet building demand. As such, most buildings are switching to Ultra-Low Sulfur No. 2 oil (ULS2), which much must be blended with a minimum of 2 percent biodiesel.

An Affordable, Quality Fuel

Biodiesel, combined with ULS2, has been shown to be the most cost-efficient alternative to traditional heating oils. Biodiesel is a clean fuel made from vegetable oils and animal fats. The fuel is easily blended with traditional heating oil fuel. B5 (5 percent biodiesel, 95 percent heating oil) blends meet the ASTM International D396 heating oil specification. Blends of B6 to B20, can be used in most boilers with minor to no modifications to the equipment per ASTM D7467. ASTM is also currently evaluating opportunities to create a new ASTM certification for blends up to B50. This provides building owners with an inexpensive alternative path for compliance.

In 2013, the price for blends of B2 and ULS2 sold in New York is averaging \$0.02 per gallon less than unblended ULS2 due to tax incentives for producers and blenders, fuel price reductions from the sale of the biodiesel renewable fuel attribute,²⁶³ and a state tax credit of \$0.01 per gallon of biodiesel (up to

²⁶¹ Bioheat is a registered trademark of the National Biodiesel Board.

²⁶² New York City Council, Introductory Bill 0194-2010, "Use of clean heating oil in New York City," August 16, 2010, Accessed August 2013, <http://legistar.council.nyc.gov/LegislationDetail.aspx?ID=660184&GUID=0F06CC07-D87E-42B1-8FB3-A7FB7E27CCCC>.

²⁶³ The renewable fuel attribute is also known as the Renewable Identification Number (RIN), which is a certificate that can be sold to obligated parties to comply with the U.S. Renewable Fuel Standard. In the past, the RIN value for biodiesel has ranged from \$.50/gallon to \$1.50/gallon or more.

\$0.20/gallon) through 2016.²⁶⁴ Compared to the No. 6 fuel, biodiesel blends are equivalent in price because of the increase in heating system efficiency, which can be up to 30 percent.²⁶⁵

Emission Reductions from Biodiesel

Emissions from buildings are the largest source of air pollution in NYC, contributing to 75 percent of total carbon dioxide emissions. No. 4 and No. 6 oil account for 9 percent of these emissions,²⁶⁶ which will be significantly reduced as the fuels are phased out.²⁶⁷ Compared to traditional heating oils, biodiesel blends produce less carbon dioxide on a fuel lifecycle basis, sulfur dioxide, nitrogen oxide, carbon monoxide, and unburned hydrocarbons.

Biodiesel History in New York City

Biodiesel has been used in commercial boilers in NYC for the past 10 years. For example, Schildwachter & Sons, a NYC bioheat distributor, has been selling B20 blends to buildings since 2005.²⁶⁸ In 2011, according to PlaNYC, buildings in NYC consumed about 901 million gallons of fuel oil, while biodiesel only accounted for 60,000 gallons. However, from 2012 to 2013, biodiesel distributors have seen a 300 percent increase in the demand for biodiesel.²⁶⁹ Tri-State Biodiesel LLC has become the national leader in B100 sales to buildings and currently has over 300 B100 customers in the NYC area.²⁷⁰

Early Tests and Successes

The New York State Energy Research and Development Authority (NYSERDA) and Cornell University began testing B20 heating oil in apartment buildings in 2005. These buildings, located at 111 West 11th Street, 175 Rivington Street, and 224 East 7th Street, had no issues with B20. In the co-op on East 7th Street, resident Fred Seiden noted, “I sleep better at night knowing that we’re not polluting the earth as much.”²⁷¹ Another complex on the Upper West Side voluntarily switched to B100 in 2012 and has also been issue-free with the conversion. This change has saved the building and residents money, with an average savings of \$0.10 per gallon compared to ULS2 before incentives.²⁷²

Results

The City of New York is leading by example as the largest municipal consumer of bioheat in the country, according to the National Biodiesel Board.²⁷³ For example, the City’s Parks and Recreation Department uses biodiesel in all 153 municipal buildings. “Following our success with the fleet, the NYC Parks and

²⁶⁴ Energy.gov, “New York State Refundable Clean Heating Fuel Tax Credit,” accessed August 2013, <http://energy.gov/savings/refundable-clean-heating-fuel-tax-credit-personal>.

²⁶⁵ Dehran Duckworth, Fuel Sales Manager of Tri-State Biodiesel, Interview by Author, September 10, 2013.

²⁶⁶ City of New York, Inventory of New York City Greenhouse Gas Emissions, December 2012, by Jonathan Dickinson, et al. Mayor’s Office of Long-Term Planning and Sustainability, New York, 2012. PlaNYC 2010 and 2011.

²⁶⁷ City of New York, Inventory of New York City Greenhouse Gas Emissions, September 2011, by Jonathan Dickinson and Andrea Tenorio. Mayor’s Office of Long-Term Planning and Sustainability, New York, 2011.

²⁶⁸ Lovece, Frank, “Biodiesel Basics: From “Oy!” to “Soy”, Habitat Magazine, accessed August 2012, <http://www.habitatmag.com/publication-content/save-the0world/biofuel-basics#.Ui8k2xYd6X1>.

²⁶⁹ Dehran Duckworth, Fuel Sales Manager of Tri-State Biodiesel, Interview by Author, September 10, 2013.

²⁷⁰ Duckworth, Dehran, Fuel Sales Manager of Tri-State Biodiesel, Interview by Author, September 10, 2013.

²⁷¹ Scherer, Ron, “New Yorkers turning to biodiesel for heat,” The Christian Science Monitor, September 18, 2007, accessed August 2013, <http://www.csmonitor.com/2007/0918/p03s01-usgn.html>.

²⁷² NYC Clean Heat, “NYC is Warming Up to Biodiesel”, accessed August 2013, <http://www.nyccleanheat.org/sites/nyccleanheat.icfwebsiteservices.com/files/NYC%20Clean%20Heat%20Biodiesel%20for%20heat.pdf>.

²⁷³ National Biodiesel Board, “Industry Groups Cheer New York Bioheat Legislation,” June 24, 2012, accessed October 7, 2013, <http://www.biodiesel.org/news/biodiesel-news/news-display/2013/06/24/industry-groups-cheer-new-york-bioheat-legislation>.

Recreation Department introduced biodiesel in heating oil for over 150 facilities in 2007. We started with B5 and then moved to B20. Bioheat use was an important part of the Parks and Recreation Sustainability Plan for internal operations, which included other exciting initiatives such as green roofs for facilities, increased public space recycling, and expanded composting,” said Keith Kerman, Chief NYC Fleet Officer and former Assistant Parks Commissioner for Citywide Operations.²⁷⁴ A total of 182 heating oil tanks have used heating oil blends of B5 to B20, with 95 percent of the heating systems compatible with B20 blends.²⁷⁵

A number of buildings have voluntarily switched to higher levels of biodiesel blends. Alexander and Blaise Dupuy, brothers and owners of a multi-family residential brownstone building in Chelsea, discovered B100 when researching lower cost fuel alternatives. “It isn’t often that you can fight climate change, protect the environment, and save money at the same time. We pay a premium of a few cents per kilowatt-hour for wind-generated electricity, but switching to B100 has not only eliminated our largest consumption of fossil fuels, it reduced our heating bills by about one-third,” said Alexander Dupuy.²⁷⁶

The building switched to B100 in February 2013, prior to the brothers being aware of the B2 mandate. The owners have not experienced any problems to date with the B100 and noticed an immediate improvement in air quality with a reduction in diesel fumes. The fuel provider, Tri-State Biodiesel LLC, proactively replaced the oil filter a few months after converting to B100 to mitigate any filter clogs; biodiesel has a cleansing effect on equipment and can displace any previously accumulated heating oil deposits. To date, the Dupuy brothers have used over 800 gallons of biodiesel, passing the fuel savings on to the tenants.²⁷⁷ They will be able to increase savings after claiming the \$0.20/gallon bioheat tax credit from New York State.²⁷⁸

Building owners have noted several recommendations when switching to biodiesel.

- Always consult the fuel oil provider before making the switch to any level of biodiesel higher than B20 to evaluate equipment compatibility and fuel availability.
- When switching to a blend over B20, gradually increase the biodiesel percentage in the tank to prevent fuel filter clogs and equipment issues.
- Cold weather creates challenges with blends over B50 if the boiler is not used continuously in the winter and the fuel storage tank is exposed to cold weather conditions.

Conclusion

Switching to bioheat in New York City is a viable and economic alternative to traditional heating oils. With the city currently requiring B2 in all heating oil, New York will begin to see a reduction in emissions and improvement in air quality during winter months. Increasing the use of bioheat will help NYC reach the PlaNYC goal of greenhouse gas emission reductions of 30 percent by 2030, compared to from 2005 levels.

²⁷⁴ Keith Kerman, Chief Fleet Officer, New York City, Email to Author, September 14, 2013.

²⁷⁵ Department of Parks and Recreation, “Parks Honored for Use of Biodiesel Technologies,” *The Daily Plant*, Volume XXV, Number 5359, March 1, 2011, <http://www.nycgovparks.org/news/daily-plant?id=22368>.

²⁷⁶ Alexander Dupuy, Interview by author, October 2, 2013.

²⁷⁷ Ibid.

²⁷⁸ Energy.gov, “New York State Refundable Clean Heating Fuel Tax Credit,” accessed August 2013, <http://energy.gov/savings/refundable-clean-heating-fuel-tax-credit-personal>.

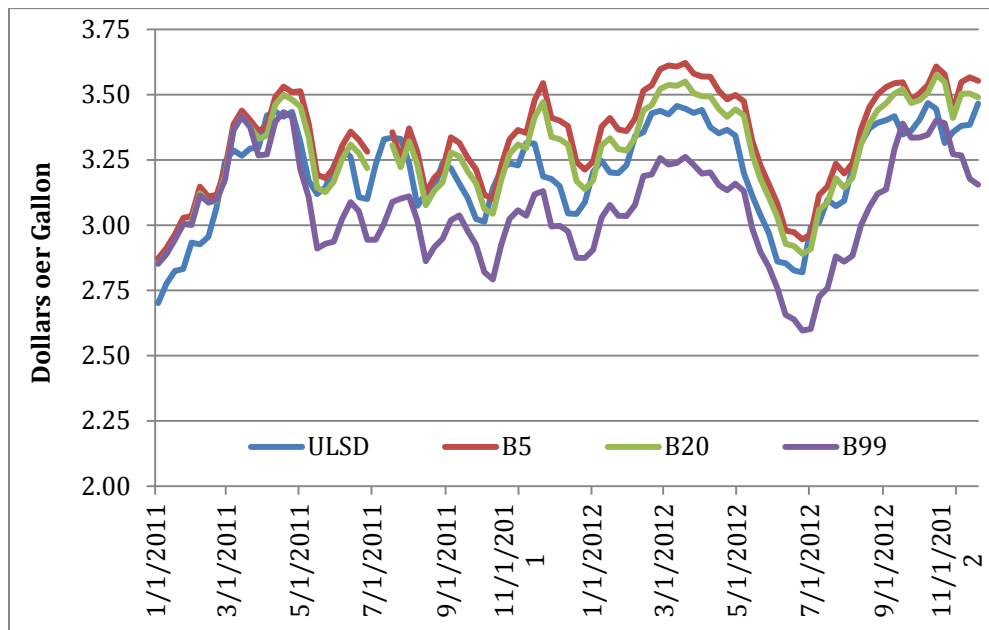
Appendix 4: Case Study: Con Edison Biodiesel Fleet

As companies work to reduce expenses while simultaneously improving sustainability, corporate fleets are turning to biodiesel as a safe and clean alternative to traditional diesel fuels. Produced in America from vegetable oils and animal fats, biodiesel is an affordable fuel for fleets that does not require significant investments in infrastructure and vehicle conversions. Con Edison is leading the way through its use of biodiesel to meet company emission reduction goals. “We are committed to mitigating climate change, and will continue to embrace new technologies and progressive corporate policies that embody our pursuit of environmental excellence,” said Randolph Price, Vice President of Environment, Health, and Safety.²⁷⁹

Biodiesel Benefits

Biodiesel is an alternative fuel that can be used in most diesel engines, is produced from vegetable oils and animal fats, and meets certain fuel quality standards.²⁸⁰ Most vehicle manufacturers permit blends of B5 (5 percent biodiesel, 95 percent petroleum diesel) to B20 in equipment without impacting the vehicle warranty. Biodiesel minimally reduces fuel economy by 2 percent for B20 and 10 percent for pure biodiesel (B100).²⁸¹ In recent years, biodiesel prices have tracked those of conventional diesel. The graph below shows the average price of ultra-low sulfur diesel (ULSD), B5 MULT, B20 MULT, and B99 MULT from 2011-2012 at UGES terminal racks in the NYC area. B99 was consistently less expensive between May 2011 and November 2012 compared to ULSD inclusive of incentives.

Average Price of ULSD, B5, B20, and B100 (in dollars per gallon), 2011-2012



Source: OPIS Oil Price Information Service, 2013.

²⁷⁹ Consolidated Edison, “News Release: Con Edison Introduces a Greener Vehicle Fleet,” June 24, 2008, accessed August 2013, <http://www.coned.com/newsroom/news/pr20080624.asp>.

²⁸⁰ ASTM D6751-09a for B100 or ASTM D7467-09a certified for biodiesel blends between B6 to B20.

²⁸¹ FuelEconomy.gov, “Biodiesel,” accessed August 2013, <http://www.fueleconomy.gov/feg/biodiesel.shtml>.

In 2013, tax incentives for producers and blenders and reductions in fuel price from the sale of the renewable fuel attribute²⁸² have allowed smaller blends of biodiesel to be cost-competitive with diesel. In July 2013, the average ULSD price in New England was \$4.07 per gallon. Over the same time period, B20 was \$3.92 per gallon and B99/B100 was \$3.80 per gallon, inclusive of incentives.²⁸³

Con Edison

Con Edison, a subsidiary of Consolidated Edison, Inc., is committed to reducing greenhouse gas (GHG) emissions and has developed an annual GHG emissions inventory since 2005. Con Edison began examining alternative fuel opportunities in the 1990s when the Energy Policy Act of 1992 (EPAAct) required Con Edison to acquire alternative fuel vehicles.²⁸⁴ In 2005, the company began a biodiesel pilot study motivated by the minimal initial investment and compatible vehicle manufacturer warranties.²⁸⁵

Results

Con Edison completed the first B20 pilot tests with fleet equipment located in Brooklyn. The tests were so successful that, in 2008, Con Edison began using B5 or B20 in all 1,700 diesel trucks as long as the fuel was compatible with the manufacturer's warranty. The fleet did experience a "gelling" issue during the winter of 2009-2010. Gelling occurs when cold temperatures cause solids to begin forming in the biodiesel, creating a cloudy appearance. If solids do form in the fuel they prevent proper diesel flow in the fuel lines and clog fuel filters. The gelling was quickly remedied once Con Edison's fuel distributor switched the biodiesel to a soy-based fuel, which has fewer known gelling issues. Drivers were also trained to use biodiesel and instructed on fuel handling, potential fuel issues and solutions, and fuel benefits.²⁸⁶ Signage has been incorporated in all of the biodiesel-compatible fleet vehicles to instruct drivers and introduce other employees to biodiesel. Con Edison staff estimate the utility has used over 1.5 million gallons of B100 since 2008.²⁸⁷

Fueling Cost and Access

Con Edison paid for a premium for biodiesel fuel over the first several years of the program, but the costs were offset by the avoided expense of purchasing EPAAct credits to comply with the federal mandate. Since 2008, biodiesel fuel prices have steadily declined. Con Edison anticipates fuel cost savings in 2013 will offset rising petroleum costs and allow the company to maintain the current fuel budget.²⁸⁸

As a large utility, Con Edison's fleet uses private, on-site refueling infrastructure. When Con Edison began converting underground storage tanks and fuel dispensing equipment to use biodiesel, the utility helped pave the way for other fleets by developing new fuel storage standards for fleets in conjunction

²⁸² The renewable fuel attribute is also known as the Renewable Identification Number (RIN), which is a certificate that can be sold to obligated parties to comply with the U.S. Renewable Fuel Standard. In the past, the RIN value for biodiesel has ranged from \$.50/gallon to \$1.50/gallon or more.

²⁸³ DOE Alternative Fuels Data Center, "Alternative Fuel Price Report," July 2013, pg. 9, accessed October 2013, <http://www.afdc.energy.gov/fuels/prices.html>.

²⁸⁴ U.S. House, 102nd Congress, 2nd Session, H.R. 776, "Energy Policy Act of 1992", 1992, accessed September 2013, <http://thomas.loc.gov/cgi-bin/query/z?c102:H.R.776.ENR.>

²⁸⁵ Interview with Bob Ceriello, David Gmach, and Fortunato Gulino, Con Edison, September 24, 2013.

²⁸⁶ Ibid.

²⁸⁷ Interview with Bob Ceriello, David Gmach, and Fortunato Gulino, Con Edison, September 24, 2013.

²⁸⁸ Ibid.

with the New York City Fire Department (FDNY). When Con Edison began the permitting process in 2009, an Underwriters Laboratories (UL) listing for biodiesel-compatible underground storage tanks did not exist. Con Edison engineers worked with FDNY to develop new department standards for storage and, in 2011, became the first non-city fleet to have permitted biodiesel fueling infrastructure at all nine fleet locations.²⁸⁹ The initial capital investment to convert the underground storage tanks were minimal, requiring only signage updates and minor valve and seal replacements, which were already part of Con Edison's routine annual maintenance schedule.

Conclusion

In 2012, Con Edison consumed 308,000 gallons of B100,²⁹⁰ which helped the utility exceed the EPA's requirement for the year. Biodiesel adds to the utility's use of hybrids, electric vehicles, and natural gas vehicles, making Con Edison a clear alternative fuel leader in the greater New York City area. According to Con Edison officials, the only limiting factor to increase biodiesel consumption has been related to restrictions within equipment manufacturer warranties. Con Edison has expressed interest in using higher biodiesel blends if these restrictions were eliminated or fuel blend allowances increased.

According to the company's 2012 annual GHG inventory, Con Edison estimates the vehicle fleet contributed just one percent of the total corporate emissions, with overall corporate GHG emissions reduced by over 45 percent in 2012 from 2005 levels.²⁹¹ In addition to reducing carbon dioxide emissions on a fuel lifecycle basis, B20 can also reduce other harmful air pollutants including an estimated 10 percent reduction in particulate matter emissions and a 21 percent reduction in unburned hydrocarbons.²⁹² Biomass-based diesel fuel consumption among private fleets like Con Edison can significantly contribute to the City of New York's PlaNYC goal of reducing GHG emission by 30 percent by 2030 compared to 2005 levels.

²⁸⁹ Interview with Bob Ceriello, David Gmach, and Fortunato Gulino, Con Edison, September 24, 2013.

²⁹⁰ Based on email communication with Joseph Dente, Con Edison, June 21, 2013.

²⁹¹ Consolidated Edison, "2012 Sustainability Report," 2013, accessed August 2013, <http://www.conedison.com/ehs/2012-sustainability-report/#gsc.tab=0>.

²⁹² AFDC, "Biodiesel Benefits and Considerations," accessed August 2013, http://www.afdc.energy.gov/fuels/biodiesel_benefits.html.

Appendix 5: Case Study: Aviation Biofuels

KLM Royal Dutch Airlines (KLM) has been a leader in aviation biofuels in the New York City (NYC) area. Between March 8 and August 22, 2013, KLM, the Port Authority of New York and New Jersey, the Schiphol Group, SkyNRG, and Delta Air Lines, launched a 25-week demonstration study, known as the JFK Green Lane program, featured a weekly commercial flight from JFK International Airport in New York to Schiphol Amsterdam Airport using aviation biofuels. “Not only do we want to develop a market for sustainable biofuel and set an example”, said Peter Hartman, President and Chief Executive Officer of KLM, “but we also want to inspire others to join us in making the airline industry more sustainable.”²⁹³

Aviation Biofuels

Aviation biofuels are produced from organic materials, such plant and animal matter, which can be blended with up to 50 percent traditional kerosene-based jet fuels.²⁹⁴ Aviation biofuels are considered drop-in fuels and do not require any modifications to the engines or fuel supply equipment. For the flights from JFK to Schipol, KLM used an average of 20 percent blend of aviation biofuel derived from camelina oil and recycled cooking oil. Each of these flights by a Boeing 777-200 aircraft was predicted to save 20 percent of the total emissions of the flight, an average of 24 tons of carbon dioxide (CO₂) per flight.²⁹⁵ Since emissions for an entire flight are attributed to their point of origin, this reduction will contribute to the PlaNYC goal of reducing 2005 CO₂ emission levels 30 percent by 2030.²⁹⁶



KLM Biofuel Operated Jet
- Photo courtesy of KLM Royal Dutch Airlines

To reduce the 2 percent of global greenhouse gas emissions generated by the aviation industry,²⁹⁷ commercial airlines began testing biofuels in 2008. This was largely spurred by the European Union’s (EU) 2008 Emissions Trading System, which developed a cap and trade system to charge flights within and from the EU with a fee based on the amount of CO₂ they produced. The program went into effect in 2012 for flights within the EU and the incorporation date for non-EU destined flights will be announced by the end of 2013.²⁹⁸ KLM has been setting biofuel aviation milestones for years, including the first biofuel commercial flight in June 2010 from Amsterdam to Paris and consistently using biofuel beginning in 2011.

²⁹³ KLM Royal Dutch Airline, “Corporate Responsibility Report 2012,” Netherlands, April 2013.

²⁹⁴ “ASTM Aviation Fuel Standard Now Specifies Bioderived Components,” ASTM International press release, July 1, 2011, accessed September 2013, <http://www.astmnewsroom.org/default.aspx?pageid=2524>.

²⁹⁵ “Weekly flight using sustainable biofuel,” KLM Takes Care, March 8, 2013, accessed August 2013, <https://klmtakescare.com/en/content/weekly-flight-using-sustainable-biofuel>.

²⁹⁶ City of New York, Inventory of New York City Greenhouse Gas Emissions, December 2012, by Jonathan Dickinson, et al. Mayor’s Office of Long-Term Planning and Sustainability, New York, 2012. PlaNYC 2010 and 2011.

²⁹⁷ IPCC, “Aviation and the Global Atmosphere: A Special Report of the Intergovernmental Panel on Climate Change,” Cambridge, 1999, accessed August 2013, http://www.grida.no/publications/other/ipcc_sr/?src=/climate/ipcc/aviation/index.htm.

²⁹⁸ “Inclusion of aviation in the EU-ETS,” European Commission, July 1, 2013, accessed August 2013, http://ec.europa.eu/clima/policies/transport/aviation/index_en.htm.

Why New York City?

The Port Authority of New York and New Jersey, the operators of all NYC area airports, was a major factor in the decision to choose JFK International Airport. The Port Authority itself uses B20 (20 percent biodiesel, 80 percent diesel) year-round for all diesel equipment ranging from airport shuttles and buses to snow plows at JFK. The Port Authority is even considering increasing to B50 blends in the future.²⁹⁹ The Port Authority contributed to the KLM demonstration by facilitating the introduction of biofuel into the jet fuel supply at JFK and loaning two 10,000-gallon refueling trucks for the biofuel operations.³⁰⁰ “If we want to make aviation more sustainable, we need to join forces”, said Camiel Eurlings, KLM Managing Director. “We are very pleased to be able to make a joint effort to lift this biofuel project off to great success, with support of Schiphol Group, Delta Airlines and the Port Authority of New York and New Jersey.”³⁰¹

KLM has an established team to operate the Biofuel Program from the Schiphol Amsterdam Airport that has been in place for several years. When the company decided to test the feasibility of intercontinental biofuel flights, JFK International Airport became the logical location choice because of these team members:

- Schiphol Group: The organization currently owns and operates Schiphol Amsterdam Airport, the home of KLM’s hub, and is also joint owner and operator of Terminal 4 at JFK.
- SkyNRG: KLM’s biofuel provider sourced the Roundtable on Sustainable Biofuels certified biofuel from America for this study.
- Delta: A global SkyTeam partner with KLM, Delta also has a major hub at JFK and a minor hub at Schiphol Airport.

Barriers to Aviation Biofuel Adoption

KLM has faced criticism about the introduction of biofuels in operations, primarily due to concerns about sustainability, biofuel costs, and infrastructure. Using biomass-based aviation fuel from virgin oils has been controversial because of the potential impact on the cost and availability of food and the environmental benefit. SkyNRG, the biofuel provider for KLM and other airline demonstration projects, is currently diversifying the feedstock supply and has incorporated sustainable virgin oils, such as camelina.

Biofuel costs are also a barrier preventing widespread fuel adoption, particularly for domestic and international flights not affected by EU fees. KLM has a voluntary program to help offset the higher biofuel cost, which allows corporate partners in sustainability to pay a surcharge with their ticket price to have part of their flight operated on biofuels. Any company representatives regularly flying with KLM

²⁹⁹ Iowa Soybean Review, “NYC Depends on Renewable Fuel throughout the Year,” March 1, 2012, accessed June 2013, <http://soybeanreview.com/article/big-city-emergencies-prove-no-problem-biodiesel-0>.

³⁰⁰ Port Authority of New York and New Jersey, “Press Release: New York and Amsterdam Unite to Launch a New Era in Sustainable Aviation Initiate First-ever Series of Intercontinental Biofuel Flights,” March 13, 2013, accessed August 2013, http://www.panynj.gov/press-room/press-item.cfm?headLine_id=1763.

³⁰¹ “Schiphol Group supports KLM with the launch of its biofuel-powered intercontinental flights,” Schiphol Group press release, March 8, 2013, accessed August 26, 2013, <http://www.schiphol.nl/SchipholGroup1/NieuwsPers/Persbericht/SchipholGroupSupportsKLMWithTheLaunchOfItsBiofuelpoweredIntercontinentalFlights.htm>.

can sign up to become part of this program to offset transportation emissions. Due in large part to the current low demand for aviation biofuels and competition for the fuel feedstock, aviation biofuels are more expensive than traditional jet fuel. However, the price could decline with technology advancements, improvements in feedstock price and availability, changes to the financial incentive structure, and increased availability of aviation biofuel refinery operations.

Results

Ultimately, four different batches of sustainable jet fuel were used as part of the JFK Green Lane program derived from used cooking oil and camelina oil. The used cooking oil derived jet fuel was produced by Dynamic Fuels, LLC (a joint venture of Tyson Foods, Inc. and Syntroleum Corporation) in Geismar, Louisiana. The camelina-based jet fuel was produced by UOP (a Honeywell company) in Pasadena, Texas. The fuel was transported to KMTex in Port Arthur, TX and blended with fossil jet A/A1 (sourced by EPIC). The fuel was tested and certified to comply with ASTM D7566 for sustainable jet fuel and ASTM D1655 for standard aviation turbine fuel. The fuel was then transported to JFK airport from KMTex using two jet fuel tank trucks. Once it arrived at JFK it was transferred by Allied Aviation to two dedicated 10,000 gallon refueler trucks where additional sampling and analysis took place. A total volume of 145,000 gallons of sustainable jet fuel blend were used on the 26 flights between JFK and Schiphol airport, realizing approximately 232 Mt of CO₂ savings.³⁰²

Conclusion

The KLM and JFK International Airport collaboration is an aviation industry success story and other airlines are also announcing exciting new partnerships. For example, in June 2013, United Airlines and AltAir Fuels (an aviation biofuels producer) announced an offtake agreement for 5 million gallons of cost-competitive biofuel each year on flights from Los Angeles International Airport beginning in 2014.³⁰³ Increased biofuel use, technological advances with fuel production, renewable fuel incentives, emission reduction targets, and government mandates are market forces driving interest and demand for aviation biofuels. KLM currently flies three direct flights per day from JFK to Amsterdam. If KLM operated just one of those flights each day on aviation biofuels, the airline could reduce CO₂ emissions by 26,280 tons each year in NYC, amounting to 4 percent of the PlaNYC goal of reducing 600,000 metric tons of CO₂ each year.³⁰⁴

³⁰² SkyNRG, "Evaluation Report: JFK Green Lane Program," March 2014.

³⁰³ "United Airlines and AltAir Fuels to Bring Commercial-Scale, Cost-Competitive Biofuels to Aviation Industry," United Airlines press release, June 4, 2013, accessed September 2013, <http://ir.united.com/phoenix.zhtml?c=83680&p=RssLanding&cat=news&id=1826859>.

³⁰⁴ City of New York, Inventory of New York City Greenhouse Gas Emissions, December 2012, by Jonathan Dickinson, et al. Mayor's Office of Long-Term Planning and Sustainability, New York, 2012. PlaNYC 2010 and 2011.

Appendix 6: Conversion Factors

Volume

1 bbl = 42 gallons

1 Mbbbl = 1,000 barrels

1 MMbbbl = 1,000,000 barrels

Energy Content per Barrel

Oil = 5.80 MMBtu/bbl

Residual Fuel Oil = 6.29 MMBtu/bbl

Diesel = 5.83 MMBtu/bbl

Average Jet Fuel = 5.51 MMBtu/bbl

Energy Content per Barrel of Oil Equivalent (BOE) for Various Fuels

1 MMBOE = 1 million barrels of crude oil equivalent

Oil = 5.80 MMBtu/bbl = 1 BOE

Average Jet Fuel = 5.51 MMBtu/5.80 MMBtu = 0.95 BOE

Diesel = 5.83 MMBtu/5.80 MMBtu = 1.00 BOE

Residual Fuel Oil 6.29 MMBtu/5.80 MMBtu = 1.08 BOE

Appendix 7: BIC Licensed Grease Haulers for NYC

The table below lists licensed grease haulers in NYC as of March 15, 2013.

BIC Licensed Grease Haulers for NYC

Trade Name	Business Name	Address	City	State	Zip
A&L Recycling	A&L Cesspool Service Corp.	38-40 Review Avenue	Long Island City	NY	11101
Allstate Power Vac Inc.	Allstate Power Vac Inc.	928 East Hazelwood Avenue	Rahway	NJ	7065
American By-Products Recyclers, LLC	American By-Products Recyclers, LLC	301 Royce Field Rd.	Hillsborough	NJ	8844
Analytical Bio Treatment Inc.	Analytical Bio Treatment Inc.	158 Linwood Ave	Paterson	NJ	7502
Bio Energy Development, Inc.	Bio Energy Development, Inc.	9 Dianas Circle	Roslyn	NY	11576
Brooklyn Bio Diesel Inc.	Brooklyn Bio Diesel Inc.	35 Sea Coast Terrace Apt 20R	Brooklyn	NY	11235
City Wide Sewer And Drain Service Corp.	City Wide Sewer And Drain Service Corp.	Po Box 350	Carle Place	NY	11514
Cmi Services Restaurant Division	The Cesspool Man Inc. D/B/A Cmi Services Re	240 Crossbay Blvd	Broad Channel	NY	11693
Darling International Inc.	Darling International Inc	825 Wilson Avenue	Newark	NJ	07105
David Zuidema Inc	David Zuidema Inc	90 Midland Ave	Midland Park	NJ	07432
Envirogreen Services, Inc	Envirogreen Services, Inc	107 Georgia Avenue - Suite B	Brooklyn	NY	11207
Environmental Services Inc	Environmental Services Inc	40 Zorn Blvd	Yaphank	NY	11980
Frontline Maintenance Inc.	Frontline Maintenance Inc.	2583 County Highway 37	Fleischmanns	NY	12430
Gotham Grease Recycling LLC	Gotham Grease Recycling LLC	301 Winding Road	Old Bethpage	NY	11804
Grease Monkeys Of NY Inc	Grease Monkeys Of NY Inc	31 Valdemar Ave	Staten Island	NY	10309
Green Horizons Technology Inc. DbA Oil Pick Up NY	Green Horizons Technology Inc. DbA Oil	783 McDonald Ave 1St Floor Ste B	Brooklyn	NY	11218
J & R Rendering Inc.	J & R Rendering Inc.	6600 Blvd East Suite 5M	West New York	NJ	07093
M & E Soap Company, Inc.	M & E Soap Company, Inc.	51 Tarn Drive	Morris Plains	NJ	07950
Mac Hudson Industries Corp.	Mac Hudson Industries Corp.	333 W 56Th Street, Ste. 6C	New York	NY	10019
Oilmatic Systems, L.L.C.	Oilmatic Systems, L.L.C.	P.O. Box 185	Keasbey	NJ	08832
Prs 95 Inc. D/B/A 95 Inc. D/B/A Parts Sinks	Prs 95 Inc. D/B/A 95 Inc. D/B/A Parts Sinks	P.O. Box 729	Copiague	NY	11726

Trade Name	Business Name	Address	City	State	Zip
Restaurant Technologies, Inc.	Restaurant Technologies, Inc.	2250 Pilot Knob Road	Mendota Heights	MN	55120
Russell Reid Co. & Mr. John	Russell Reid Waste Hauling And Disposal	Po Box 130	Keasbey	NJ	08832
Scientific Fire Prevention Co.	Samiro Services, Inc. D/B/A Scientific Fire P	47-25 34Th Street	Long Island City	NY	11101
The Doe Fund, Inc.	The Doe Fund, Inc.	232 East 84Th Street	New York	NY	10028
The Fatman, LLC	The Fatman, LLC	46 Maitland Avenue	Hawthorne	NJ	07506
Tri State Biodiesel LLC	Tri State Biodiesel LLC	531 Barretto Street	Bronx	NY	10474
Tully Environmental Inc.	Tully Environmental Inc.	127-50 Northern Blvd	Flushing	NY	11368
Unity Fuels, LLC D/B/A Grease Lightning	Unity Fuels, LLC D/B/A Grease Lightning	315 5Th Avenue	New York	NY	10016

Source: BIC, 2013.³⁰⁵

³⁰⁵ New York City Business Integrity Commission, "Licensed Carters – Grease Haulers", April 2013, accessed June 2013, <http://www.nyc.gov/html/bic/downloads/pdf/pr/licapproved.pdf>.