Biodiesel School Buses

How Biodiesel Can Help Local School Districts Save Money,

Improve Health, and Reduce Emissions

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EXECUTIVE SUMMARY

The use of diesel fuel in school buses presents several problems; it has a high cost and produces harmful emissions, namely particulate matter, which can be very damaging to public health, especially in children. These problems can largely be mitigated through the use of biodiesel as fuel. In some cases school districts have an untapped reservoir of cheap fuel that can be used to power school buses. Through the use of several chemical processes, all of which can be completed at local processing facilities, discarded waste vegetable oil from public buildings (i.e. school cafeterias) and residences can be converted into biodiesel that can be used to directly power school buses. Biodiesel is an alternative fuel source that emits far fewer pollutants, particularly sulfur oxides and particulate matter, and significantly less carbon dioxide over its lifecycle than traditional diesel fuel and costs substantially less to produce.

Furthermore, the use of biodiesel as fuel for school buses is not merely conceptual- it is a feasible solution with successful implementation as a fuel source in school buses. It also offers the potential for cost savings for a school district through both reduced fuel costs and reduced maintenance costs. The various methods of biodiesel implementation for a school bus fleet may vary depending on the school district's local conditions. However, all offer comparable and noticeable emissions reduction with the use of biodiesel blends. One option is third party support of biodiesel production. This method has been successfully executed since 1997 in Medford Township, NJ and provides cost savings through reduced maintenance. Another method, school district – supplier partnership, would have a school district provide its used cooking oil to a biodiesel producer and receive a discounted price

on biodiesel. The third method, locally managed biodiesel production, has a school district producing its own biodiesel from collected oil, as has been completed effectively in Hoover, Al. This method offers the highest amount of savings through both reduced fuel cost and reduced maintenance cost, but requires a large amount of waste vegetable oil to be available. Upfront costs for the third option could be displaced by revolving loans disbursed through the Clean Diesel Campaign, created as part of the EPA to help disburse funds from the Diesel Emissions Reduction Act. Additionally, a waste vegetable oil collection program should be set up for residences. The oil would be collected along with the recycling, or central donation centers could be made available.

EPA regional offices could compile a list of waste vegetable oil disposal amounts, possibly through a pilot program. This would help determine available amount of oil for use in biodiesel production. Based on these results, the offices would then perform a biodiesel feasibility study to determine the best possible method of biodiesel implementation. Additionally, a sub-program within the Clean Diesel Campaign that focuses solely on biodiesel would help to inform school district of the benefits, both financially and in terms of health, of switching to biodiesel. Finally, the restoration of DERA's funding to previous levels would help ensure the success of a wide array of diesel emissions reduction technology.

FOREWORD

ABOUT THE AUTHOR

Nathan Sacks is a rising 4th year at the Georgia Institute of Technology with a major in mechanical engineering and a minor in energy systems. His interest in biofuels began in high school when he converted his car to run on waste vegetable oil. At Georgia Tech, Nathan researches hydraulic based start-stop systems for school buses. His primary academic and professional interests lie in the field of renewable energy. Outside of classes, Nathan enjoys bicycling, good music, and good food.

ABOUT THE WISE PROGRAM

The Washington Internships for Students of Engineering (WISE) Program was founded in 1980 as a collaboration between several professional engineering societies with the goal of introducing engineering students to the realm of public policy and its interaction with science and technology. Each student is sponsored by a professional engineering society and spends the summer in Washington, D.C., where he/she investigates a technology-relevant public policy issue and develops his/her own policy recommendations to resolve the topic. Nathan was sponsored by the American Society for Mechanical Engineers (ASME). For more information on the WISE Program, please visit http://www.wise-intern.org/.

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INTRODUCTION

This paper will present a policy analysis of why school buses should run on biodiesel blends and how the federal government is playing a role. It will address the growing concern over the high cost of diesel fuel as it relates to public school transportation. The cost is not only manifested in rising fuel expenses, but also in deteriorating public health. The cost of diesel fuel has increased significantly over the past 20 years, from around $1 per gallon to nearly $4 per gallon. This increase has placed additional strain on state education budgets, which were already reduced in light of the recession (U.S. Energy Information Association). School buses are often in service for 20 years and as they age, they emit more pollutants than they did in their original conditions. Unlike gasoline, the combustion of diesel fuel emits fine particulates in addition to other pollutants; diesel exhaust is considered a probable human carcinogen (Wargo).

Passed as part of the Energy Policy Act of 2005 (PL 109-58), the goal of the Diesel Emissions Reduction Act (DERA) (Sections 791 to 797) was to fund projects aimed at reducing a maximum amount of particulate emissions. Renewed with new provisions in 2010 (PL 111-364), DERA authorizes funds, which have ranged from a maximum of $100 million to $300 million annually, to be distributed by the Environmental Protection Agency's Clean Diesel Campaign. Appropriated funding has fluctuated between $50 million to $60 million per year for the first four years since FY2008. However, funding was significantly reduced to only $30 million for FY2012, followed by $20 million for FY2013 (Environmental Protection Agency, Funding). The Obama Administration's proposed FY2014 budget further reduces DERA's funding with a 70% cut, bringing it to $6 million.

Figure 1 illustrates the varied levels of funding. Additionally, the American Recovery and Reinvestment Act of 2009 (ARRA) (PL 111-5) provided $300 million in stimulus funds. The EPA estimates that every $1 investment made by DERA yields $13 in health and environmental benefits (National Clean Diesel Campaign). DERA is scheduled to expire in 2016.

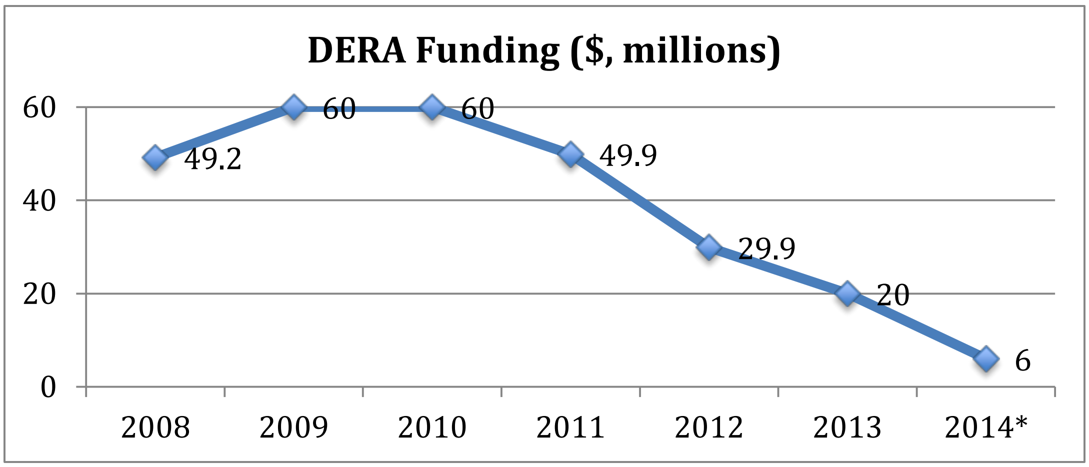

Figure 1: DERA Funding Levels (Environmental Protection Agency, Funding)

DERA grants have provided funding for almost "60,000 pieces of clean diesel technology," and most projects received between half a million to two million dollars (Environmental Protection Agency, Funding). The majority of these funds, 70%, are allocated for grants and low-cost revolving loans. While 90% of the allocated funds are used for existing, tested technologies, the remaining 10% go towards developing new technologies. DERA stipulates that half of the funds be distributed to public vehicles, including school buses. The Clean Diesel Campaign, which disburses DERA's funds, works to "…ensure that clean diesel projects are as cost-effective as possible while targeting high exposure areas…" (Office of Transportation and Air Quality 5). Because these funds are often aimed at retrofits and reducing the most significant amount of emissions possible, projects that offer only a moderate amount of emission reduction despite potential cost savings can be overlooked. If these projects were to be funded, then it would be possible to obtain a significant amount of emission reduction as well obtain cost savings. The projects are aimed at a wide variety of large, non-consumer diesel vehicles, not purely school buses. However, because children are disproportionally affected by school bus exhaust, school buses represent an area where relatively small changes in school bus configurations can have a large impact on health.

There are currently numerous emission reducing technologies, but biodiesel is noteworthy in that it has the potential for significant cost savings as well. Biodiesel, which can be produced from waste vegetable oil from public buildings (i.e. school cafeterias), can be mixed with diesel fuel and can be used in diesel vehicles without any modification. Additionally, the use of biodiesel as fuel for school buses is not merely theoretical, but has been successfully implemented in a variety of ways in multiple locations around the country.

ISSUE DEFINITION

The problems resulting from America's dependence on fossil fuels have become more apparent with cash strapped state budgets and deteriorating public health, among other issues. According to the American School Bus Council, the 480,000 school buses in the United States drive a collective of 5.76 billion miles in the course of a single school year (American School Bus Council). The price of diesel fuel has skyrocketed in the past two decades (Figure 2). In 2012, the average price was $3.968 per gallon; this number represents a 33% increase over 2010, a 60% increase over 2009, and a 258% increase over the first year for which data is available, 1995 (U.S. Energy Information Association). With an average school bus fuel consumption of 7 miles per gallon (mpg), the estimated total cost of diesel fuel for all school buses in 2012 was $3,265,097,143 (American School Bus Council). As diesel fuel prices continue to increase, overburdened school districts will have to allocate a larger portion of state funding towards transportation costs, diverting it from education.

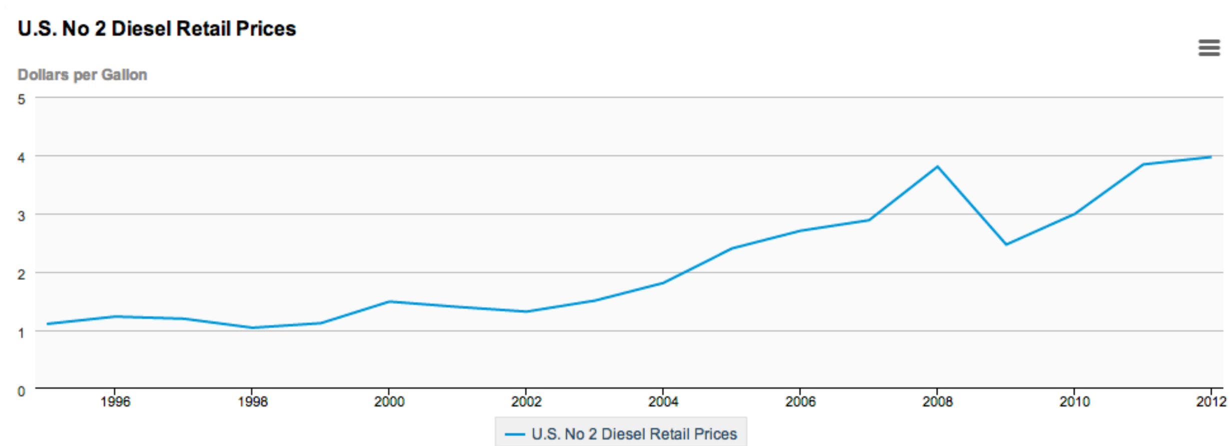

Figure 2: U.S. Diesel Retail Prices (U.S. Energy Information Association)

Public health costs due to diesel particulate pollution is estimated to be as large as $139 billion per year (Clean Air Task Force). Children, due to their developing respiratory systems, are at a greater risk to poor air quality. It is estimated that 4.5 million US children have asthma, although not all of these cases can be attributed to diesel particulate exhaust. Exposure to diesel exhaust can produce inflammation and irritation of airways and can exacerbate symptoms in children that already have respiratory illness (Clean Air Task Force).

Traditionally, diesel engines have been used in heavier and industrial applications due to their high efficiency, high torque, peak torque at lower RPMs, and the low cost of diesel fuel. These advantages over gasoline engines have outweighed the problems of diesel, namely the high particulate exhaust and greater noise. Despite recent increases in the cost of diesel fuel, making it more expensive than gasoline, diesel fuel is still preferred for many applications. School buses began widespread use in the 1930's with diesel engines being the preferred choice of power. Although the American School Bus Council recommends school buses be replaced every 12 years, this is not always possible in financially difficult times. The result is that school buses can continue operation for up to 20 years in some areas (Wagner). This presents a noteworthy health risk as newer buses produce much less particle emissions than older buses; for example, school buses built before 1993 can emit between 25-60 times more particle emissions than those built in 2007 (Texas Office of Environmental Defense).

BIODIESEL

Biodiesel, despite its dissimilar chemical composition, is a fuel similar to diesel in terms of combustion properties, but is created from vegetable oil in a chemical conversion process primarily involving methanol and lye. It is not a hydrocarbon and can be created from both new vegetable oil and waste vegetable oil that has been filtered, and from a wide variety of oil types with soybean oil being the most common; however, other common sources include canola oil, sunflower oil, waste vegetable oil, and animal fats (Environmental Protection Agency, Technical Highlights). In fact, the first diesel engine, unveiled by the engine's inventor Rudolph Diesel at the Paris Exhibition in 1900, was powered by peanut oil. Petroleum diesel only began use as a fuel source due to its low cost at the time.

The past decade has brought about significant changes in the transportation sector and fuel sector. There has been a major push by industry, consumers, and the government to promote non-traditional fuel sources, from hydrogen to ethanol. The pressure to increase biofuels production has likewise produced a shift in the collection of waste vegetable oil.

In the past, restaurant owners had to pay for a service to collect their discarded waste vegetable oil in accordance with state and local environmental regulations. This allowed hobbyists, those who made biodiesel for personal use in their own vehicles, to offer to take away a restaurant's oil for free. But, as biodiesel became a lucrative business opportunity, many collection services began offering to take a restaurant's oil for free as well in order to make their own biodiesel. In some cases, collectors began paying restaurants to collect their oil. Although the price depends on the quality of oil collected, the amount collected, the frequency of collection, and market forces, collectors can pay $0.20 per gallon or even more. This new revenue stream for a restaurant or other oil producing business does not offer a substantial source of income, but it is well received nonetheless and can help offset other business expenses (Mantilla).

BENEFITS

The use of biodiesel or biodiesel blends instead of petroleum diesel as a fuel has several benefits. Primarily, the combustion of biodiesel produces significantly lower amounts of carbon dioxide over the lifecycle of the fuel. Additionally, the use of B20 (20% biodiesel, 80% diesel) offers 21% reduction in unburned hydrocarbons, 11% reduction in carbon monoxide, and a 10% reduction in particulate matter. Furthermore, the use of B100

(100% biodiesel, 0% diesel), boasts 67% reduction in unburned hydrocarbons, 48% reduction in carbon monoxide, and a 47% reduction in particulate matter (Environmental Protection Agency, Biodiesel Emissions iii).

Because biodiesel can be produced from waste vegetable oil and not solely new vegetable oil, there is the potential for significant cost savings over diesel fuel. The most expensive element of biodiesel production is the vegetable oil needed as feedstock. Assuming a free source of waste vegetable is available, the primary recurring capital costs of biodiesel production are the chemicals necessary to convert the oil into biodiesel; these chemicals are a small expense at roughly $0.60 per gallon (Environmental Protection Agency, Hoover). This expense is relatively minor compared to the high cost of diesel fuel. Additionally, the use of biodiesel does not require any modifications to existing diesel engines.

CHALLENGES

Although a wide variety of biodiesel blends can be used in a diesel engine, including B100, most engine warranties only cover operation up to B20. Biodiesel has a higher cetane rating and increased lubricity compared to diesel. While these qualities actually help clean out deposits and result in better engine performance, the cleaning effect can clog fuel filters. For this reason, it is recommended that filters be changed soon after switching to high blends of biodiesel. Additionally, rubber gaskets and hoses on older diesel engines can deteriorate with the use of higher percentage biodiesel blends (Environmental Protection Agency, Technical Highlights). Furthermore, while B20 has been shown experientially to have no net increase of nitrogen oxide emissions, B100 can present up to a 3% increase (R.L. McCormick), thus increasing smog levels.

Biodiesel also has reduced fuel economy as compared to diesel fuel; in the case of B20, testing has shown a reduction between 1-2 percent (Environmental Protection Agency, Biodiesel Emissions iii). However, experiential testing has shown this is not always the case (Biluck). Storage of the waste vegetable oil and biodiesel can present problems if they are stored incorrectly as certain storage conditions can render the biodiesel or vegetable oil temporarily unusable. However, it is possible to simply reprocess the fuel to bring it back to the necessary quality. A final consideration for the use of biodiesel is its operating temperature range. There have been successful reports of using B20 in weather as cold as eleven degrees below zero, but climates regularly experiencing colder weather would have to consider limiting biodiesel use, primarily higher percentage blends, to warmer months (Biluck).

POLICY ALTERNATIVES

EDUCATION CAMPAIGN

The Environmental Protection Agency established the Clean Diesel Campaign in order to successfully proceed with its role as established in the Diesel Emissions Reduction Act. The Clean Diesel Campaign disburses DERA funds and creates awareness of initiatives underway that reduce diesel emissions. It also provides information about available loan and grant funding in order to reduce diesel emissions. However, there is the potential to go further. A sub-program that focuses solely on biodiesel could be created within the Clean Diesel Campaign. The primary concentration of this program would be, first and foremost, to educate school districts on the benefits of biodiesel and the steps necessary to create a biodiesel program. EPA regional offices have the ability compile data on school bus fleets to determine which buses serve the poorest air quality areas or serve the most children. This could be accomplished in a pilot program in order to properly assess the feasibility of such an endeavor. While the EPA currently has resources available to learn about diesel emission reduction programs and possibilities, there is little incentive for school districts to reach out to learn more.

In the case of biodiesel there are a lot of incentives for a school district to make the switch, but many are unaware of the potential benefits. The EPA could send out information to school districts with a summary of information on biodiesel, how it has been successfully implemented in other areas, and its benefits and challenges. Again, a pilot program could be initialized in one EPA region in order to determine the success of the outreach. In addition to the compiled list of school bus fleets, the EPA could compile data on waste vegetable oil availability of a school district or region. This data would include not only the amount of waste vegetable oil disposed of by public buildings, but also the amount disposed of by local restaurants and households in the area. Together, this data could be used to assess the viability of biodiesel production in a specific location. Going further, it would be possible to calculate the potential cost savings and emission reductions possible from a switch to biodiesel. The EPA would not be expected to determine the number of gallons of waste vegetable oil disposed of by each individual facility or person, but compile data that each facility already has available. In the case of individual waste vegetable oil amounts, one possibility is the inclusion of this information on census polls.

The primary incentive for school districts to participate in providing school bus fleet and waste vegetable oil data would be the potential that the results of a feasibility study could result in substantial cost savings for the school district. One possible way method of incentivizing participation would be to give preferential treatment of DERA funds to participating school districts. Another possibility is to only allow access to the results of the feasibility study to schools that participate in data collection.

RESIDENTIAL WASTE VEGETABLE OIL COLLECTION

Through this information, a waste vegetable oil collection service could be implemented in tandem with current programs like trash and recycling pick-up. One potential option is for households to pour their excess oil into an extra plastic container similar to the one that contained their new vegetable oil. Once the container is filled, it would be placed in the recycling bin to be collected just like other recyclables. This oil would be placed at a central collection facility where it would either be sold to a waste vegetable oil collection service or biodiesel producer, or used by the region for their own biodiesel production. In cases where this additional pick-up capacity in not feasible, citizens should be advised that chemical disposal centers will take residential supplies of waste vegetable oil.

IMPLEMENTATION

OVERVIEW

There are a significant number of ways a school district could incorporate biodiesel into its school bus fleet. Several considerations include: the size of the school district's bus fleet, the age of its buses as well as their intended lifespans, the amount of waste vegetable oil discarded by public buildings, and the amount of local government control over the biodiesel production process. The most significant of these considerations perhaps is the local conditions; the possibilities can vary from a biodiesel producing facility managed by the local government to completely contracting out the process depending on the available supply of waste vegetable oil. The result of the varying levels of operation is a range of possible costs and savings.

This section will analyze many of the different possibilities for biodiesel implementation into a bus fleet and how they will affect fuel costs and savings. All of the below scenarios will assume the use of B20 biodiesel and will compare the different costs associated with different ways of utilizing biodiesel. In terms of emission reduction, they all offer the same reductions in using B20. These reductions include: 21% reduction in unburned hydrocarbons, 11% reduction in carbon monoxide, and a 10% reduction in particulate matter (Environmental Protection Agency, Biodiesel Emissions iii).

THIRD PARTY SUPPORT OF BIODIESEL PRODUCTION

One possible implementation of biodiesel into a school bus fleet is complete third party support for the biodiesel production process. In this scenario, the school district receives B20 for the school bus fleet from a biodiesel supplier much as they would from a standard diesel supplier. This route is the safest in terms of fuel liability as the fuel supplier is completely liable for fuel quality, but is also the costliest. Medford Township, the first school district in the country to use biodiesel in their school buses, has had this program in place since 1997 without any issues.

According to Joe Biluck, former diesel mechanic, current Director of Operations and Technology in Medford Township, and the person in charge of the implementation of the biodiesel program there, purchasing the biodiesel from a supplier is slightly costlier than purchasing diesel fuel. In his experience, the cost of B20 was roughly $0.20 per gallon more

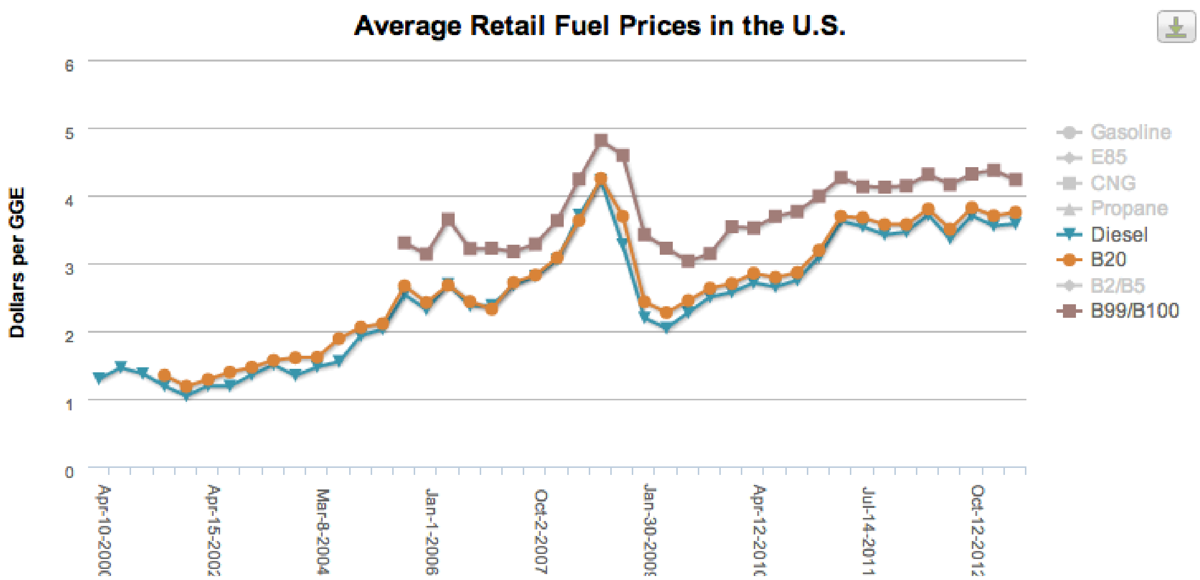

Figure 3: Average Retail Fuel Prices in the U.S. (Clean Cities, Fuel Price Report)

than diesel. Although the price of B20 follows the price of diesel fuel very closely, the price differential between the two fluctuates (Figure 3). On average, B20 costs $0.13 more per gallon than diesel. However, based on Medford Township's experience with biodiesel, there was an overall decrease in operating cost for the school buses running on B20- a reduction of approximately $0.02 per mile. This equates to $10,000 in savings per year for the district of about 40 school buses. Mr. Biluck attributes these operating cost savings to the increased oxygen content and lubricity of biodiesel which causes the engine to run smoother and cause less vibration, leading to decreased wear on brackets and supports. He also noted a longer lifecycle of the exhaust systems and lower failure rates for the injection system.

SCHOOL DISTRICT – SUPPLIER PARTNERSHIP

Another possibility for implementing a biodiesel program is one in which the school district supplies the waste vegetable oil from public buildings for biodiesel producers. In this case, the district may or may not collect the vegetable oil from public buildings and deliver it to a biodiesel supplier. Many biodiesel producers also offer collection services, although this would cut into the potential cost savings for the district. The benefit of providing the waste vegetable oil to biodiesel producers is that it removes the most expensive component of the biodiesel- the initial fuel.

However, this waste vegetable oil must go through a process in which it is filtered and water is removed before it can be converted into biodiesel. This oil, which has undergone filtering and dewatering, but not biodiesel conversion, is referred to as yellow grease. Similar to the price of diesel fuel, yellow grease and biodiesel are both subject to market forces and price fluctuations. Using these numbers, it is possible to obtain an approximate cost of biodiesel acquired via this method, although biodiesel producer margins are ignored. As of April 2013, the national average price of B20 was $4.11 per gallon compared to $3.99 for diesel fuel (Clean Cities, Fuel Price Report). Additionally, the price of yellow grease was roughly $2.70 per gallon (Agricultural Marketing Service). Ignoring the fees charged for conversion, and potentially collection costs, on the part of the biodiesel producer, this brings the cost of B20 to $3.57 per gallon, 11% cheaper than diesel fuel (Asher).

LOCALLY MANAGED BIODIESEL PRODUCTION

The creation of a locally run biodiesel production facility and oil collection program offers the most significant possibility of risk, but also reward. In this scenario, the school district builds and operates its own biodiesel production facility. It also runs its own collection service in order to acquire the waste vegetable oil. Because no third party is involved, all cost savings go directly to the district. Economics of scale also dictates that multiple school districts could combine resources and run a larger biodiesel production facility than would be possible by individual districts, cutting both short term and long term biodiesel production costs.

An arrangement similar to this has been implemented in Hoover, Alabama. Their successful implementation of a biodiesel program has yielded significant cost savings as they pay between $0.80 and $0.90 per gallon of B100. Taking this low cost of fuel into account, they had a return on their investment in approximately 200 days (Environmental Protection Agency, Hoover 21). Compared to the current cost of diesel fuel at $3.99 per gallon, this offers up to an 80% savings in fuel cost, assuming vehicles run on 100% biodiesel. But, because bus warranties only cover up to B20, more likely cost savings would put a B20 blend at $3.35 a gallon, which still offers a 16% reduction in fuel cost.

One potential problem with government operating their own biodiesel production facility is liability for fuel problems. In the case of bad fuel acquired from a third party vendor, the operators are held accountable. In the case of a district managing their own biodiesel plant, they are fully accountable for any vehicle problems that arise due to fuel problems. This contrasts with the case of an outside biodiesel contractor who would be held accountable for lackluster biodiesel quality due to poor initial oil supply. However, tests can be performed in order to determine waste vegetable oil quality and spoiled oil can be prevented from entering the fuel supply.

ECONOMIC ANALYSIS

The potential cost savings due to a switch from diesel to B20 in school buses primarily relies on who is providing the biodiesel and, in the cases where a school district is providing the waste vegetable oil supply, how much oil is available for use. Recent initiatives to provide healthier food in school cafeterias reduce the amount of vegetable oil used as fried foods are removed, although it is unlikely for them to be nationally removed altogether. The following economic analysis will entertain each of the above three biodiesel production implementation possibilities separately as well as take into account varying levels of available waste vegetable oil. The analysis will limit the scope to the potential cost savings for the United States as a whole. Additionally, it will not take into account locations where B20 biodiesel blends may be unsuitable due to low winter temperatures, though that consideration will be balanced out by areas where excess biodiesel production may allow for B20 use in other public vehicles, not just school buses. Additionally, jobs created as a result of the increased need for biodiesel are not taken into account.

In the production of biodiesel, there are three distinct costs: biodiesel conversion equipment, chemicals required for chemical conversion, and the initial fuel supply of vegetable oil. In the case of complete third party biodiesel support, the contractor is responsible for the all of these costs and they are reflected in the price the buyer, the school district, pays for biodiesel and do not need to be included in price calculations. The same is true with intelligent waste vegetable oil disposal, although the school district will be supplying at least a small portion of the waste vegetable oil.

In the scenario where a school district is unable to provide any waste vegetable oil for biodiesel conversion and must completely rely on third party support, there is less potential for cost savings. Historically, biodiesel has been priced slightly above diesel. However, based on Medford Township's experience with biodiesel, namely reduced operating costs while running on B20, there is still potential for cost savings in addition to emission reduction. Medford's experience showed a two-cent per mile operating cost reduction on B20. Assuming the school buses averaged seven miles per gallon, there was a savings of 14 cents per gallon. Thus B20 remains cost competitive with diesel in instances where it is priced up to 14 cents per gallon more than diesel. From October 2001 (the first time B20 prices were monitored) through April 2013, the price of B20 has been an average of 13 cents more expensive per gallon than diesel fuel. Thus, a net one-cent per gallon decrease in fuel cost could be expected with a switch to B20- a potential yield of over $7 million dollars in savings for the country annually in addition to the significant emission reduction; this does not take into account public health savings that are attributed to the reduction in diesel exhaust.

In the case of a school district – supplier partnership, as described above, there is potential for nearly an 11% reduction in fuel cost (from $3.99 to $3.57 per gallon), ignoring third party fees. This could mean over $300 million in fuel savings. Taking this into account with the prospective 14 cents per gallon decrease in maintenance costs with B20, this could account for over $400 million in cost reduction. To date, no example of this method of implementation has been identified. Furthermore, locally managed biodiesel production offers up to 16% (from $3.99 to $3.35 per gallon) lower fuel costs with B20 and offers almost $500 million in cost savings for the country annually. Including the reduction in maintenance costs, the savings approaches $600 million. These numbers do not include the infrastructure costs necessary to make the biodiesel. However, the costs necessary to maintain a biodiesel production facility are small compared to the potential cost savings (Environmental Protection Agency, Hoover 21). It should also be noted that these two scenarios assume that school districts can supply the complete source of waste vegetable oil necessary to make the biodiesel. As more oil is required from an outside source, potential savings from fuel diminishes although public health still reaps the benefits. The calculation method for the savings described in this section can be found Appendix I: Calculations.

RECOMMENDATIONS

SUMMARY

The use B20 as fuel in school buses will not counteract all of the health and emission problems associated with diesel fuel nor will it save a school district's budget. However, the combination of cost savings via reduced fuel cost as well as reduced maintenance costs offers an incentive for school districts to consider using biodiesel. Additionally, the use of biodiesel will promote health savings and improve air quality.

The following are recommendations to be considered based on the findings of this paper:

- EPA regional offices should compile list of waste vegetable oil disposal amounts. This should first be completed in a pilot program to properly assess the viability of such a survey. This information is important in order to determine subsequent considerations for biodiesel use.
- EPA regional offices should complete biodiesel production feasibility studies in order to determine the potential for the various methods of biodiesel implementation in different areas of the country. Again, a pilot program would be most useful to effectively gauge a school district's ability to execute each biodiesel implementation option.
- In areas where a prominent biodiesel supplier already exists, school districts that have a negligible amount of waste vegetable oil should look to utilize third party support of biodiesel production. A school district – supplier partnership is preferred in areas where a school district can supply some quantity of waste vegetable oil to the biodiesel producer; it makes the most sense if the quantity is either too little to warrant creating a locally managed biodiesel production facility, or if the school district does not wish to do so.
- School districts that have a large quantity of waste vegetable oil at their disposal should strive to create a locally managed biodiesel production facility in order to achieve the most significant amount of cost savings. DERA funding should provide support with the upfront infrastructure costs necessary to create the facility and begin the biodiesel production process.
- A waste vegetable oil recycling program should be employed in order to take advantage of residential oil. It could be combined with existing recycling programs

in the area. Residents would pour their excess oil in a plastic container similar to the one the oil was initially contained in.

- A sub-program that focuses solely on biodiesel could be created within the Clean Diesel Campaign. The primary concentration of this program would be, first and foremost, to educate school districts on the benefits of biodiesel and the steps necessary to create a biodiesel program.
- The bipartisan and widespread support for the Diesel Emissions Reduction Act as well as its noteworthy success indicate that its funding should be restored to previous levels, at least $30 million.

DISCUSSION

The viability of biodiesel implementation in a school district relies most heavily on the size of the district, the availability of a local biodiesel producer, and the amount of waste vegetable oil produced by the public buildings in the district.

Locally managed biodiesel production has been successfully implemented in several places around the country and illustrates the largest amount of fuel savings potential. Due to its success as a model, it is recommended for use in all available scenarios in which there is a sizeable and available supply of waste vegetable oil from public buildings. The risks associated with poor fuel quality are mitigated with proper testing of waste vegetable oil prior to processing. Additionally, advanced biodiesel processing equipment makes processing the waste vegetable oil into biodiesel a much simpler process than previous, largely manual methods, and further work to ensure necessary fuel quality. The initial investment of the equipment is quickly returned through the cost savings associated with the switch to B20.

Districts that have a large amount of unclaimed waste vegetable oil from public buildings, but are risk averse to producing their own biodiesel, or lack the manpower do so, should consider the option of a school district – supplier partnership. By having a third party use waste vegetable oil from public buildings, the school district ensures fuel quality liability on the part of the biodiesel supplier but still enjoys the benefits of reduced biodiesel cost. Of course, an agreement would be necessary to guarantee fuel quality from the supplier in addition to a lowered cost of biodiesel due to the district supplying the oil. Depending on available collection vehicles, the district could collect their waste vegetable oil on behalf of the biodiesel producer for additional cost savings.

Complete third party support for biodiesel production makes the most sense for districts with little or no available waste vegetable oil, or in cases where there is an existing contract for waste vegetable oil collection from public buildings. This scenario offers a minimal amount of cost savings and in some cases may increase the cost of fuel, if only slightly. It is important to keep in mind, however, that often times reduced maintenance costs is the result of a switch to B20 and this can offset the additional fuel costs that arise from using biodiesel.

In instances where there is a viable supply of waste vegetable oil, but not enough for all school buses to run on B20, there are severable acceptable options. If the school district is primarily urban and located in areas with poor air quality, lower biodiesel blends should be used, be it B10 or B2. Even fuel containing small amounts of biodiesel mixed with petroleum diesel has been shown to have noticeable benefits (Clean Cities, Biodiesel Blends). Another possibility is to prioritize buses running on biodiesel blends based on certain criteria. Buses that transport many children, operate in urban areas, or operate in areas with poor air quality would have priority in fueling with biodiesel.

Education and outreach are key components prior to introducing the above scenarios. Although several innovative areas around the country have enjoyed the benefits of a school bus fleet running on biodiesel blends, they do not represent more than a small fraction of districts that could benefit from the above implementations. In order to take advantage of the vast and largely untapped reservoir of waste vegetable oil created by public buildings, there needs to be a more widespread effort to inspire the willingness of school districts, counties, or even states as a whole, to commit to looking into novel ways of simultaneously cutting both fuel costs and emissions. Biodiesel represents a possible solution, but only if there is the effort to invest in and create the initial infrastructure necessary to make it happen.

Education can help at the community level as well. Outreach efforts to get citizens to donate their used cooking oil have proven successful and yielded substantial amounts of waste vegetable oil. Most major cities offer recycling programs in which recycling is collected similarly to refuse. A similar program could be implemented in order to collect the reservoir of vegetable oil used by households. Households would pour oil into a container similar to the one that initially contained the oil. Since households do not use or discard nearly as much waste vegetable oil as restaurants, oil disposal could be incorporated into existing recycling programs where available. In areas without a recycling program, the oil could be donated at a collection facility, or the biodiesel production facility itself. Many states already offer chemical collection facilities that will accept residential waste vegetable oil.

Finally, in order to properly assess the viability of biodiesel and how it should be implemented, the EPA should compile data on school bus fleets across the country as well as data on the amount of waste vegetable oil used by public buildings in school districts and how it is currently being disposed of. The responsibility of acquiring the data on school bus fleets would remain with the school district, as it is already available, and the information would be submitted to the regional EPA offices. With this information, the potential savings created by switching to biodiesel can be computed and the appropriate method of implementation can be determined. The conclusions of the analysis would be submitted to the school districts (or counties or states, depending on the results) as suggestions, with results focusing on reduced costs due to both fuel and public health as well as decreased emissions.

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APPENDIX I: CALCULATIONS

ASSUMPTIONS/GIVEN

- Cost to produce B100: $0.80/gallon
- School Bus Fuel Economy: 7 miles per gallon
- Maintenance cost reduction: $0.02/mile = $0.14/gallon
- The cost of B20 is, on average, $0.13/gallon more expensive than diesel
- 90% of school buses have diesel engines, 90% of fuel will be diesel
- Number of miles driven by school buses per year: 5,760,000,000
- Retail price of diesel fuel: $3.99/gallon
- Retail price of B20: $4.12/gallon

THE NUMBER OF GALLONS OF DIESEL FUEL USED BY SCHOOL BUSES PER YEAR

= (5,760,000,000 / 7) * 0.9 = 740,571,429

COST SAVINGS OF B20 COMPARED TO DIESEL

THIRD PARTY SUPPORT

Additional Fuel Cost: 740,571,429 * ($3.99 - $4.12) = 96,274,285

Maintenance Savings: 740,571,429 * .14 = $103,680,000

Net Savings: $7,405,715

SCHOOL DISTRICT – SUPPLIER PARTNERSHIP

Fuel Savings: 740,571,429 * ($3.99 - $3.57) = $311,040,000

Maintenance Savings: 740,571,429 * .14 = $103,680,000

Net Savings: $414,720,000

LOCALLY MANAGED BIODIESEL PRODUCTION

Cost of B20: $3.99 * 0.80 + $0.80 * 0.20 = $3.35

Fuel Savings: 740,571,429 * ($3.99 - $3.35)= 473,965,715

Maintenance Savings: 740,571,429 * .14 = $103,680,000

Net Savings: $577,645,715