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Application of Biomass Fuels

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Applications of Biomass Fuels

Abstract

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Derrek Rueger, Hiroshi Kino and Michael Steidel

The purpose of our study is determining if biomass fuel is a feasible means of meeting the quota of renewable energy by the Renewable Portfolio Standards (RPS). Interviewing parties involved in the industry, we gathered information regarding the efficiency of biofuel in power generation, and its competitiveness with other renewable energy sources. While biodiesel is currently the most popular alternative to fossil fuel, recycling biomass is a means of supplementing energy while reducing the volume of waste and greenhouse gases.
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Section 1. Introduction

It should be abundantly clear that fossil fuels—while efficient—will not be a reliable means of power generation indefinitely. Fossil fuels are a limited resource and many recent projections on the longevity of the fossil fuel industry suggests currently known fossil fuel reservoirs will dry up within the century. Specifically, an article from USA Today predicts that the world will run out of fossil fuels completely in 53.3 years (DiLallo, Nov. 1, 2016) Therefore, it is imperative that alternative fuel and energy sources be developed before we do run out and our current infrastructure collapses. However, given how much investment lies within the fossil fuel industry, and how much profit the industry yields, it seems incredibly unlikely that companies will be willing to branch too far out from these tried and true methods of power generation of their own volition unless it becomes urgent. Yet the unfortunate reality is that the current reliance on fossil fuels is unsustainable; the current rates of consumption far exceed the rate at which these fuels are produced naturally. Many states across the country have enacted a solution that does far more than encourage the transition to the use of fossil fuels, in fact, their solution mandates it. All commercial power companies within a subset of states in the US are required to ensure that a certain percentage of their annual power output comes from sources of power which meet the criteria of the Renewable Portfolio Standards (RPS). In order to count toward meeting the RPS in states like Massachusetts for example, electricity must be produced by a renewable power generator which began production after the year 1997 and must come from one of the following sources: solar photovoltaic (commonly just solar generators), solar thermal electricity, wind energy, small hydropower (such as dams), methane siphoned from landfills, anaerobic digester gas (typically also methane) or other eligible biomass fuels, marine
or hydrokinetic energy (from the open ocean), or geothermal energy. Many states have adopted these renewable energy mandates in the form of RPS in varying amounts, however all have their own initial renewable energy requirements, and have agreed that these percentages will increase annually (NREL, Sept. 10th, 2016). In Massachusetts in particular, as of 2016 it is required that all power suppliers on the grid maintain a percentage of power from RPS approved sources of 11%. Every year, this amount is mandated to increase by 1% (RPS and APS Program Summaries). In order to uphold this, every Kilowatt Hour (KwH) of electricity which is bought and sold by a power company is required to be documented as RPS approved, or not. Should a company not meet the requirements set in place by the state government within which it is located however, a company will be fined. The total amount of the fine is also determined by the state laws, but many agree that the amount paid will be based off of the percentage by which the company fell below the requirement. Additionally, it is established by the RPS that the money paid to the government through these fines will be used to assist the development of future renewable energy generators.

While the requirements appear rather reasonable, some power companies are failing to meet them, and paying fines hurt their business and may make it more difficult for said company to meet these increasing requirements in the future. For example, two of Massachusetts’ largest utility companies struck an agreement with Cape Winds’ efforts to establish a wind farm off the shore in Nantucket Sound. These companies would buy power from Cape Wind once the project was completed and planned to sell it all to increase their renewable power supply. If all things went according to plan, the project would be complete in 2019. However, despite promising outlooks for the Cape Wind program, they were set back by lawsuits and problems acquiring permits, and the project became a failure. As a result, the utility companies involved in this
arrangement must now find new renewable energy sources to purchase from, or risk failing to meet their RPS requirements for 2019. The utility companies who attempted to work alongside Cape Wind are far from the only victims to such complications, as both privately and publicly owned power distribution companies are often responsible for buying the power that goes through them to the consumers. In order to do so it falls upon the companies to seek out and make deals with newly constructed renewable energy generators, whom they put a lot of faith into. Should these ventures fail- as a result of generator construction being delayed or cancelled- it is likely to cause the original company to fail to meet their RPS mandates for the year and incur the associated fines. These fines are small, and are not designed to put any utility companies out of business, yet they can put a strain on their budget and may make it more difficult to meet the following year’s RPS mandate as well. However, these renewable mandates cannot be done away with, as they are essential to incentivize the transition toward renewable energy. As such, instead of creating an alternative to the RPS, a solution must be developed to make renewable energy more widely available to both consumers and utility companies.

Currently the most sought after form of renewable energy generators come from sources like wind, photovoltaics and hydrokinetics. This neglects other viable types of generators which are available and being improved just the same. In fact, the focus of these studies will be one of these less frequently considered, yet newly improved sources of renewable energy generation; those such as anaerobic digesters and other biomass fuels.

Our initial plan was to research alternative forms of fuel and energy and what is currently being done to reduce the use of fossil fuels. We began our research by looking into Renewable
Portfolio Standards and Renewable Energy Mandates, as well as the effect that these standards and mandates have on companies that provide power. Through this preliminary research, we learned about biomass-based fuel, or biofuels. Due to our new-found interest in biofuels we decided to put particular focus on them and compare them to other, more traditional alternative forms of energy, such as solar, wind, and hydroelectricity. After doing some research into biofuels we found that there was a lot to be said about biofuels. We then decided that biofuels were better suited for the topic of our paper than the RPS would be.

With this change in plan and topic, we were forced to change many of our research goals. Our primary focus became looking into how biofuels could be further developed, utilized, and implemented into our existing infrastructure. In order to better understand this how this could be done, we would need to look into the current state of development of biofuels and the biofuel industry. Conversely, we would need information about what setbacks biofuels face that prevent them from becoming more widespread. However, much of what we found early on was still relevant to our research.
Section 2. Background

When the topic of renewable energy arises, people often picture generators such as wind turbines, solar panels, or hydroelectric dams. Other type of generators are increasing in popularity lately, and can not only produce power, but also renewable fuel as a byproduct of disposing of waste products. These generators are known as dry-mills, biodiesel refineries and biodigesters, which output their products when provided with plant and/or animal matter, which is collectively referred to as biomass. The mills are responsible for creating renewable liquid fuels by grinding and fermenting sugar rich plant matter into ethanol, while biodigesters act like a stomach which digests and solid waste matter into biogas. Similarly, biodiesel refineries consume waste products like used deep fryer grease and yellow cooking oil to create a molecule with is completely natural, but functionally identical to diesel fuel. The goals of these generators—much like their free energy counterparts—is to present renewable alternatives to power generation methods and fuels which are capable of rivaling fossil fuels in cost, efficiency and greenhouse gas emissions. Not only are these generators additional means of creating power and fuel that are up to Renewable Portfolio (RPS) and Alternative Fuel Standards (AFS), but they break down food and plant waste while they do so; as such it is believed that generation of energy through biomass is a worthwhile investment for the future, especially as an alternative to traditional fossil fuels.

There are various kinds of biofuels which are split mainly into two different types, First generation and second generation (or advanced) biofuels. First generation biofuels are created from sugars, starches and oils. This kind of biofuel uses feedstock that is not sustainable or, if
created in mass quantities would reduce from the food supply. Furthermore, in order to increase the production of first generation biofuels it is often necessary to allocate more land toward agriculture. The majority of the biofuels in use today are considered first generation biofuels, but both varieties will be the focus of our studies. Second generation biofuels are considered “greener” and have lower impacts on greenhouse gas emissions. They also comparatively have a lower impact on food supply and land requirements than their first generation counterparts. Second generation biofuels are currently underdeveloped and are not widely available but several organizations recognize the potential and hope to further develop their usage.

Section 2.1. Varieties of Biomass Fuels

Starting with a look at first generation biofuels there are three types of biofuels that are commonly produced: ethanol, biodiesel and biogas. Ethanol is produced by taking in sugar rich crops, such as corn, extracting the sugars and starches from the material to then ferment them to produce and distill into ethanol. The end result is often mixed into gasoline to produce more eco-friendly transportation fuels by displacing some of the gasoline. This mixed fuel then has lower greenhouse gas emissions than pure gasoline while sacrificing a very small amount of performance.

Similarly, biodiesel is refined from biodiesel facilities which put vegetable oils and an alcohol—commonly methanol and ethanol—through a process known as transesterification. This process functions by converting triglycerides in the feedstock into biodiesel, a molecule that is very similar in form and function to diesel. Transesterification is done by a base catalyzed reaction for deprotonating the alcohol in order to speed up the process to create ethyl
esters (biodiesel). Biodiesel can be used instead of petroleum in machines and vehicles which would ordinarily use diesel fuel to reduce emissions and avoid using fossil fuels. Due to the fact that biodiesel is a substitute to traditional diesel, this particular variety of biofuel—like ethanol—is used as a transportation fuel instead of in power generation. It is worth considering despite this fact, as even as a transportation fuel biodiesels can offset use of diesel fuel. In addition, since the production of biodiesel, the fuel has also been used in another form referred to as bioheat. In fact, several producers of biodiesel start up their companies by marketing their product for bioheat. With a slight modification, furnaces can be made to burn biodiesel to reliably heat homes instead of natural gas. Thanks to these multiple uses and the abundance of feedstock for producing biodiesel, currently biodiesel is the most popular form of biomass fuel.

The third and final biomass fuel is biogas. Biogas is a mixture of gases consisting of primarily methane and a smaller amount of carbon dioxide that is produced when plant and animal waste is put into a biodigester. Within these machines waste is decomposed in a sealed oxygen-less environment by anaerobic microorganisms. On average the fermentation process takes roughly 27-28 days for a batch of waste to be digested completely. While in the digester, these organisms break down the provided waste and release methane as a byproduct. The product can then be used as a fuel gas that can be burned to convert to electricity and heat. This burning converts methane into carbon dioxide. Because this carbon dioxide comes from organic material the emissions are considered part of the natural carbon cycle, which reduces carbon emissions by replacing fossil fuels that would add carbon dioxide into the atmosphere. However, because methane is a high impact greenhouse gas, biogas is required to be handled carefully and securely as to not accidentally leak methane into the air to avoid environmental harm. As an example of a biodigester, the Saskatchewan Research Council has created a biodigester which is capable of
creating roughly five cubic meters of biogas constituted of roughly 60% methane and 39% carbon dioxide per day which makes roughly six gallons of gasoline worth of energy per week (What is a Biodigester, Sept. 24, 2016).

Section 2.2. Benefits of Biofuels

In addition to the environmental benefits biofuels present, they also present potential economic benefits. Jobs will be created for the production and distribution of biofuels, as well as for growing the feedstock necessary for production. Studies have shown that the development of a domestic biofuel industry can create a significant number of jobs, with many projecting that as many as 20 million jobs could be created by the year 2030. In fact, biofuels have already shown their potential to create jobs. In 2013, the organization known as Environmental Entrepreneurs announced an increase of 1,984 jobs in relation to biofuel projects, as well on top of an increase of 1,773 jobs in relation to biogas and biomass projects seen the previous year (Biomassmagazine, Sept, 25th, 2016).

The cost of constructing a biorefinery, a facility with the purpose of converting biomass into fuels and power, much in the same way an oil refinery does with oil, can be upwards of $100 million and can take approximately 3 to 4 years to complete. An example of how much a biofuels plant can cost is the plant that the company INEOS Bio opened in Florida in 2013 that cost $130 million to build (Biofuelnet, Sept. 25th, 2016). This doesn’t include the costs of operating the plant, maintenance, land, the price of feedstock, producing and transporting the biofuel, engineering, interest on loans borrowed to construct the plant, regulatory approval, or any other miscellaneous costs.
Although there is still a long way to go in developing biofuels and refineries, there has been significant headway made in recent years. The US Energy Information Agency reported that global biofuel production saw an increase of almost 500% from 2000 to 2010, an increase from 315 thousand barrels of ethanol and biodiesel per day to 1856 thousand barrels per day (Economics of Biofuel, Sept. 25, 2016). In 2011, President Obama announced that the U.S. Departments of Agriculture, Energy and Navy would invest $510 million over the following three years to develop the domestic capacity for advanced biofuels (Whitehouse.gov, Sept. 25th, 2016).

Section 2.3. Future Investments in Biofuels

With the eight digit figures floating around when it comes to discussing the costs associated with investment in, maintenance and development of biofuels and refineries it can seem like an expensive means of expanding the renewable energy industry. Illustrating this point is the fact that the issue of whether or not to continue this investment in the biofuel industry is one of many topics which appear in electoral discussions such as the Iowa Caucuses, where lobbyists encourage candidates to support the continued refinement of corn into ethanol. As of now the costs of the refinement process, transport, and abundance of corn cause ethanol to be more expensive per gallon, and yield less energy than gasoline. Yet with encouragement in the form of bills from the government, ethanol makes its way into the fuel market anyway. For example, oil companies in the US are mandated to mix 10% of ethanol by weight into all gasoline sold. This fuel mixture is also known as E10, and plays a key role in letting ethanol remain a competitive fuel (EERE, Oct. 2nd, 2016).
Should we wish to continue increasing the production and consumption of ethanol however, action must be taken to alter the piping of vehicles and refineries. Current materials used in these pipes are projected to be able to handle a mixture of up to 15% ethanol by weight (E15) but this results in potential breaches of government safety codes as this concentration ethanol begins to become corrosive. Piping for all machinery designed for refining, storing and consuming ethanol in the future would have to be constructed from new materials capable of withstanding these corrosive conditions, but in most cases, they currently are not. Some newer vehicles and gas pumps however are beginning to be constructed with the ability to contain and consume “flex fuels,” which contain an ethanol percentage by weight of up to 85% (E85) (EERE, Oct. 2nd, 2016). Currently these machines are not that common; some people may not even know that their cars are flex vehicles—as they are also capable of operating on lower concentration mixtures of gasoline and ethanol— and those that are aware might struggle to find gas stations which have flex fuel pumps. The engines of these vehicles put into perspective the comparative performances ethanol and gasoline when used as fuel, because while vehicles designed to run on flex fuels reach higher performance and produce higher torque, flex vehicles generally get about 30% less gas mileage per volume running on E85 than they would if they were to use E10, not to mention that currently E85 costs more (EERE, Oct. 2nd, 2016). Aside from the higher performance, this mileage is offset by the fact that the fuel is renewable by Alternative Fuel Standards (AFS) and that emissions are significantly closer to zero, but oftentimes environmentally conscious people are willing to make that tradeoff.

However, liquid fuel represents only one aspect of what biofuels have to offer, and as such there are more policies to incentivize the use of biofuels to these ends as well. Only the sugars and starches of plant matter are refined into ethanol and this leaves behind a substantial
volume of solid waste. As of October 1st 2014, the state of Massachusetts had a ban imposed by
the Department of Environmental Protection (MassDEP, Sept. 25, 2016) on incineration of food
waste products from any institution or industry which produces more than one ton of food waste
each week. Any business found producing more than this amount and throwing it away will be
forced to pay a fine. Rather than paying these fines, businesses are finding it much more cost
effective to compost these materials, as by doing so some even receive tax benefits. Others still
might accept payment from interested biomass fuel producers to take care of waste disposal for
them, however most frequently these organizations contract composters and fuel producers to
take waste material off of their hands. Not only do these arrangements provide the same cost
benefits to the food services, they also allow fuel producers easy and cheap access to supplement
their feedstocks. As development of biodigesters continues, commercial and food industries
might find even more benefits in bringing their waste to a biorefinery along with agricultural
waste to contribute to an increase in renewable energy, which appears to be a promising
investment.

With the current technology available in the biomass fuel industry, there is a substantial
amount of potential to be seen. Current means of generating electricity from liquid biofuels are
inefficient, but conferences hosted by the National Biodiesel Board hope to encourage continued
development. While biogas shines as a reliable energy source, it is biodiesel that is currently the
most refined subsection of the biomass fuel industry. In accordance, these will be the focal point
of our studies.
Section 3. Research Methods

In order to find out how effective biofuels can be for meeting renewable portfolio standards, there are many questions that arise. For example, how easily can these sources be implemented to the power grid? There are also questions of how biofuels compare to other renewable sources of energy, such as how much more or fewer kilowatt-hours biofuels can produce relatively. How much of various resources does producing biofuel take and whether or not it takes more or less than its competitors is important to figure out and learn. We must also consider new developments for biofuels that could potentially be realized and if they would be worth the effort to implement them. Each of these questions are vital to coming to an effective and well-developed conclusion to whether or not biofuels can be useful to meeting renewable portfolio standard requirements. Our team agreed that it would be the most effective to interview those involved in some shape or form with biofuels or energy.

Of the parties we talked to, the most important ones were the companies and individuals who own and maintain their own biodigesters and biofuel refineries. Although we were able to gather a lot of information about the process of running biodigesters and biorefineries from various articles, talking to those who are well versed in the industry and have first-hand experience gave us a deeper understanding of how these companies got to be in the position they are in and how they continue to operate their facilities. Through these people and the information that they provide us, we were able to learn about things such as costs to build, upgrade, repair and maintain their source of biofuel. We could also learn more about how much they can produce, how much they sell their energy for or if they use this source privately, how much of the total energy they use come from the biofuel allowing us to discern if this could help people
live off the grid or can potentially greatly reduce the amount of energy from nonrenewable sources people use.

Another group of potential interviewees were those who run various organizations that work with biofuel companies and those that lobby for them and/or potentially run conferences about different biofuels. These parties ended up helping us to better understand the political side of working with biofuels such as potential tax breaks or government support that companies receive and those if any who oppose biofuel development within or around the government and for what reasoning. They were also able to give us a good idea of how biofuels are doing overall in the country and how they can potentially differ within different areas of the United States. Potentially, biofuels could be an effective solution in a more rural area of the US but harder to implement or various issues may arise when implementing them in an urban setting such as Boston or Worcester. These people were able to help us clarify on these nuances if there are any as they work with a multitude of different companies that each come from different settings.

Overall, it was imperative that we selected our interviewees carefully and considered each of their credentials when weighing their opinions. For example, if there are conflicting opinions between various interviewees, it is most likely safer and more convincing to support an interviewee who has been working on biofuels for many years over someone who recently entered the industry. Even for well credentialed interviewees it is still important to properly evaluate what they say and avoid ignoring potential flaws that may arise from their statements.

While conducting our methods we found that electrical generation from biofuels was underwhelming however, found biodiesel to be a significant factor in transportation fuels and found more information pursuing this topic. Our attempts to look into information from utilities were not receiving significant amount of biofuel produced electricity and ultimately not very
helpful for providing us information. Failed projects and dissenting opinions were also difficult to find, failed implementations cannot be found as readily as successful companies and thus we could not find any despite our search this led us to modify our methods to more heavily focus on biodiesel and finding individuals who own biodigesters to find information.
Section 4. Results

Currently it appears to be that the most developed and common industry for biofuels is the biodiesel industry. Refineries come in a wide range of sizes from small companies such as Maine Standard Biofuels producing 500,000 gallons of biofuel a year according to their director of outreach and technology Alex Pine, to something large as Newport Biofuel, whose president Blake Banky told us produces 4.5 million gallons a year. Both of these companies collect and buy used cooking oil from many different restaurants and fast-food chains across the New England area. According to Blake Banky, Newport Biofuel produces biodiesel that is 86% cleaner than petroleum distillates. While somewhat more expensive and always will be, Blake believes that looking for alternative fuels and reducing our carbon footprint to take care of our environment is very important. Both of these companies produce biodiesel continuously taking roughly 2 to 4 days to refine the cooking grease collected into biodiesel. These biodiesel producing companies also sell the biodiesel themselves. By doing so they receive a blender’s credit for selling mixtures of biodiesel with a very small amount of petroleum. This is an unfortunate necessity as the credit is intended to incentivize petroleum companies to incorporate biodiesel in their product. However both companies showed interest in changing this credit to a producer’s credit, in hopes it would promote giving credit to the producers of biodiesel instead of giving credits to oil companies for mixing in biodiesel. Both companies when asked about the benefits between biofuels and other sources of renewable energy claimed that the strength to biofuels is its ability to be processed and produced regardless of conditions compared to solar and wind power, which while effective, cannot be produced on demand.
After interviewing the biodiesel producers, we interviewed those who support and work with producers. We interviewed, Aubrey Kreider, who works as the marketing manager for Amerigreen Energy which is a wholesaler of biodiesel and biogas. We also interviewed executive director Laura Lester of the South Carolina Soybean Board (SCSB) which is a checkoff board for soybeans. The SCSB unifies those who work in agriculture and collects funds to improve the soybean farming industry. Both of the representatives of their companies spoke highly of soybean produced biofuel as they provide high quality oil that is quickly refined compared to those created by cooking grease and thrown away vegetables. Soybean is widely produced and their oil is plentiful but did not have many uses until recently. Current developments in the biofuel industry has allowed farmers to separate their soybeans into oil and meal. This allows the farmers to make money and also reduces the carbon footprint of farming by creating feedstock for biodiesel producers. Soybean oil is the most common feedstock for biodiesel as it is produced across the entirety of America and in more rural areas the most available oil for processing compared to cities where restaurants and food providers are more common place. Those at the Soybean Board give grants to colleges and research institutes to find and improve on uses of soybeans including the production of biofuels.

We then later talked to the National Biodiesel Board. They work with many producers and organizations to represent the biodiesel industry within the US. They work with politicians and hold conferences for biodiesel developments across the country. They also help the EPA define the volume of biodiesel that should be in the fuel stream every year and ensure production and consumption can match it. We were able to talk to their director of communications Jessica Robinson. She talked and helped us understand the development of biofuel across the years on a
national level. In the early 2000s, only about 25 million gallons of biodiesel were produced in a year. Thanks to recent developments this amount has increased nearly a thousand times. In 2015 2.1 billion gallons have been produced, and in 2016, 2.6 billion gallons of biodiesel were produced. Currently the US liquid fuel system has a 3 billion gallon capacity, allowing for and anticipating the continued growth and potential of this biodiesel. Statistically they have shown that over half of the biodiesel produced today comes from soybean oil in America reinforcing what we have learned from Laura and Aubrey. One of the things that the biodiesel board worked for the industry was having biodiesel classified as an “Advanced Biofuel” in the Renewable Fuel Standard Program (RFS) under the Energy Policy Act of 2005 (EPAct) maintained by the EPA. “Conventional Biofuels” are listed as biofuels that were current at the time the policy was passed mainly ethanol blends and at the time Biodiesel. Tax reductions exist for biomass fuel production through blender’s credits and road tax breaks. This reduction can only be claimed on a limited 15 billion gallons of conventional biofuel production, however. While these credits worked to encourage development of biodiesel early on, in recent years the production has exceeded these limits, and not all conventional biodiesel producers can enjoy the full extent these benefits any longer. However, with persuasion from the National Biodiesel Board, they have managed to have biodiesel classified as an “Advanced Biofuel,” a distinct type of biofuel that fits the guidelines listed by the RFS. To be called an advanced biofuel, sources are required to be able to grow based on how big the demand for them could be, reduce greenhouse gas emissions by 50%, cannot impact land use and must still be renewable. While initially it was thought that biodiesel did not have potential as it existed alongside ethanol, The National Biodiesel Board convinced the EPA to classify Biodiesel as an advanced biofuel from their arguments that biodiesel did meet the requirements. The government has continued to renew the blender’s credit that the
biodiesel producers benefit from each year and continue to work to keep the credit in place. However, they would very much rather the producer’s credit as it avoids dependence from imports of petroleum. When asked about potential opponents to the Biodiesel industry, Jessica replied by saying that there are actually very few opponents to biodiesel as Democrats agree with fighting against global warming with alternative fuels and Republicans appreciate using and promoting American soy production and avoiding foreign oil. The main party against biodiesel is the oil industry itself. By requiring Biodiesel blends from the oil industry, they are forced to put competing product with their product. Jessica told us it’s like “a policy that requires a Coke dealer to put a can of Pepsi in every 12 pack of Coke.” When asked about potential for other uses for biodiesel outside of transportation fuels, Jessica claimed that bioheat is the next largest market and home heating oil can be mixed with biodiesel to be as clean as natural gas. On a smaller scale, biodiesel can be used in small, temporary electric generators treated to have biodiesel as a useable fuel source. Currently there is no large electric biodiesel generators.

Next, we were able to talk to Louie Aragi, of Pine Island Farms, a local farm that has owned a biodigester since 2011. He started looking to build a biodigester in 2006, looking for grants and funding. Using cow manure that is produced by the 760 cows on the farm, along with liquefied food waste from local companies and spoiled milk from local farms, Louie fuels his 650,000 gallon capacity digester, producing roughly 200 kW per hour and 144,000 kWh per month. Using a continuous flow of feedstock, it is heated to 101 degrees Celsius over 21 days producing gas that goes through a combustion engine. During the summer, he used 140 kW per hour and sent the extra kilowatts to the grid and net metering. The heat produced by his digester is also used to heat the various buildings at the farm recycling heat from the biodigester. Louie is currently looking to build another one as he has found that he has enough feedstock to fuel it
consistently. He also claims that the second digester could be particularly helpful when the a single digester can end up under maintenance for up to 9 days. Currently, Louie is trying to secure clean carbon credits with the California Carbon Exchange. However a company such as Pine Island that is currently receiving Class I renewable energy certificate (REC) cannot receive clean carbon credits at the same time. Louie claims that digesters are more deserving of the carbon credit compared to windmills as greenhouse gasses are actively being captured in a digester. Overall Pine Island Farms shows the usefulness of a digester provided they have the means to build it and give the digester sufficient feedstock.

Lastly we interviewed Michael Van Brunt, the Director of Sustainability for Covanta. Covanta is a company that burns waste and siphons greenhouse gases that are created within landfills to produce electricity. Covanta was established as an energy-from-waste facility replacing incinerators which simply burned trash to reduce volume. At the time, incinerators had been shut down due to EPA regulation. In the 1980s to early 1990s old smaller landfills were closed by these EPA regulations and this reduced the capacities of landfills across the US. Regulation policies demanded for renewable power and energy pricing allowing Covanta to be able to establish a plant that now burns 20 million tons of waste. Instead of just incinerating the fuel and releasing the smoke into the atmosphere, Covanta captures the vapors to produce high pressure steam that is put through a turbine creating roughly 550 to 700 kWh per ton of renewable energy. Covanta receives waste by being contracted to assist with waste management from a variety of municipalities and companies. Power generated is sold to local utilities and is not regulated as a retail provider of electricity. They are paid roughly 6 cents per kWh as of 2015. They also recycle metals recovered from the facilities and sell them. Michael told us that he would like to see the US come closer to the numbers that various European countries do for
recycling as they have a 60% to 70% recycling rates and would like to see more material management policies.
Section 5. Analysis of Feedback

While we struggled to establish contact with every party that we tried to interview for our studies, from the handful which we did get a chance to talk with, we found quite the variety. Our very first interviews were with two biodiesel producing companies of vastly different scales but surprisingly similar methods and views. We began with Newport Biofuel which drew its feedstock of yellow cooking oil from 3,000 restaurants across New England, and Maine Standard Biofuel which drew the same feedstock from a smaller count of 900 restaurants, neither of which ended up competing with the other. The similarities did not end here, nor did they when other biodiesel producing companies got added into the mix.

When asked, neither biodiesel producer expressed any interest in selling their product for use in power generation through utility companies. Instead, they reported that they preferred to have their respective sales departments handle all of their business exchanges selling their product. Furthermore, they primarily restricted these sales to be on a local level, where their product would be used as a substitute to natural gas and home heating oil, or diesel and gasoline for transportation fuel. These producers, much like most other owners of biomass based refineries prefer to be self-sufficient (Banky, Pines). At this point in our research, we were already beginning to recognize a pattern in these responses, and it led us to wonder why it was that these companies took care of their own sales rather than handling sales through a utility company. As stated previously in our background chapter, most large scale utility companies see no power generation from any sort of biomass fuel producer, which led us to ask why. As it turns
out, many large-scale utility companies make certain demands from producers that they deal with. Frequently the quantity of fuel and power demanded by these large companies exceeds the potential of even large scale biofuel producers like Newport Biodiesel (Banky). With the current capabilities of biodiesel burning generators, biodiesel producers cannot keep up with the demand of utility companies.

In other circumstances, where a utility company is not the primary buyer of a biogas producer’s power, the utility will assume that any electric power from said producer will be wasted if not sold and offer a significantly lower price for the power. As an example, Pine Island farm—a primarily family owned business from Berkshire County Massachusetts—explained in an interview that the primary consumers of their power supply established a net metering partnership with the farm. Under this arrangement, local businesses from neighboring towns were able to use power directly from the anaerobic digester just as the farm equipment which belonged to Pine Island did. Every month these local businesses would send a check to Pine Island Farm to pay for the power that they used, and any excess power they needed would come from the public utilities and be paid accordingly. In certain months, output of the anaerobic digester could exceed the combined usage of Pine Island and its net metering partners. At this point in our interview Pine Island explained they were asked to sell as low as two cents per kilowatt hour (KwH) of power whenever they reached this excess—which is notably low considering consumers in Massachusetts usually purchase power at an average of twelve cents per KwH (Aragi). Should the company in question needed to buy more renewable power it is likely that a better deal could have been arranged, but this was not the case.

While different in size regarding their machinery and workforce, producers like Newport and Maine Standard biodiesel both began on the same scale with the same goals in mind. They
each began as a small collection of about five people each who expressed interest in using biodiesel to heat their homes back in the year 2006. From that point, both found success as more people began to become involved with said organizations while they began to expand their feedstocks and machinery. By the time the year 2010 came around Newport and Maine Standard as well as several other biodiesel refineries across the country began to flourish with the help of new research and funding from lobbies which began to spring up such as the South Carolina Soybean Board and the National Biodiesel Board (NBB). In the interview with the NBB this pattern was visible across the country as production of advanced biodiesel has increased from 25 million gallons annually to 2.1 billion gallons produced in 2015 (Robinson). While as of now we have only heard from the two biodiesel producers, by contacting the NBB—who has access to information regarding producers throughout the country—we were able to find out that Maine Standard and Newport Biodiesel were far from the only companies whose development followed this trend. Additionally, on a smaller scale the South Carolina Soybean Board (SCSB) was able share with us specific examples of how these lobbies and boards raise money and carry out research for these topics. As the search for companies involved with production of biomass based fuels continued it was the biodiesel companies that directed us to these organizations which helped them to find the success they enjoy today.

Section 5.1. Checkoff Boards

We were able to learn from the NBB and SCSB that every state in the US has an organization to manage a checkoff system in order encourage the development and protect the interests of their respective renewable energy feedstocks and producers. These checkoffs are
similar to a small percentage tax dollars which are taken when growers of specific feedstocks sell their crops. In the case of the South Carolina Soybean Board, this miniscule percentage of money (0.5% the cost of each bushel) is directed toward funding research in both colleges and labs.

While research for an individual state is the primary expense for checkoff money, on a federal level national checkoff organizations pool money together to perform research which would prove valuable to producers regardless of the state in which they work (Lester).

The focus of this research is specifically directed toward developing agriculture, in an effort to increase appeal, efficiency and security of the field. Particularly in South Carolina, the Soybean Board made it known that a particularly large focus of their research was directed toward dealing with pests. More specifically these funds were put toward developing strategies to deter deer and worms from consuming the crops without needing to jeopardize the quality of the soybean crop with chemicals. Beyond pests, breeding methods to make the crops more resilient to frost were also researched in an effort to increase yields and maximize the security of farmers’ investments each year they plant. While the SCSB directed their research toward increasing the security of investing in soybeans, the NBB reported that a large portion of their research this year would be directed toward developing practical methods for extracting usable power out of liquid biodiesel, rather than the product simply being a heating or transport fuel.

The SCSB was eager to share with us that while each state has its own similar board, the checkoff system works differently in each state—whether by percentage of costs per unit taken, crops that fall under the checkoff, and where the funds are directed. To speak for the effectiveness of the programs, with the help of these checkoff dollars the profound discovery was made that soybeans could be broken down into both meal and oil. With this separation, not only is the oil produced more pure and efficient as a fuel source, but the leftover meal can be used as
animal feed while the oil remains able to be used in cooking oil, which can then be recycled as feedstock for biodigesters. With this ability to separate the crop into two usable components, farmers in the area are granted access to a crop that they can sell as a biomass fuel and still be able to feed their livestock. Previously, these farmers who produced biomass feedstock would be reluctant to agree to selling their crops. In the case with crops like corn and soybeans before this discovery, it was required that the crop be used in its entirety as either food or fuel. Simply put, farmers had to decide how much of their crop would be fed to their animals, and how much they would sell. As a result of this breakthrough from the SCSB, farmers no longer need to make this choice.

At the suggestion of the SCSB we also got the opportunity to speak with and learn about the NBB. Much like the state level organizations in charge of checkoff programs such as the soybean board, the NBB had vast amounts of information to share with us on the matter production and presence of biodiesel across the US. While we had only currently spoken to two companies involved in the production of biodiesel, we were able to affirm that the similarities we saw between them held true across the country. Producers were all more than happy to create their own sales department to give themselves the liberty of naming their prices and picking their sales partners. Furthermore, by not making agreements with these large utility companies, biodiesel producers and biodigester owners can avoid massive quotas of power generation per period of time, as well as set their own more reasonable prices for their product.
Section 5.2. Biofuel Wholesalers

On the subject of selling products, check off boards are not the only organizations that have formed in order to assist the development of businesses in the biomass fuel industry. Due to the frequency at which companies that deal in biofuel opt not to get into business agreements with public electrical utility companies, the door is opened for wholesalers like Amerigreen to lend a hand. Wholesale companies do exactly as the name suggests, they act as a middleman to buy power or fuel from a producer and then turn around and sell the same product wholesale to any consumer party that might be interested, whether that’s individual consumers, public or private utility companies. Therefore, biodiesel, bioheat and other biomass fuel producers can easily find someone to sell their product to on their own terms without having to dedicate themselves to large quotas and low prices that would come from working directly with companies like National Grid or General Electrics. While Amerigreen was the only wholesaler among the subjects of our studies, they were happy to inform us that they were far from the only wholesaler in the US, and were part of the Renewable Energy Group. Furthermore, the representative at Amerigreen was proud to announce that they were a total energy partner. This title is given to any wholesaler who does not limit itself to the purchase and sale of a selection of renewable fuels and power sourced, but all of them. Amerigreen deals not only in bioheat and biodiesel, but also in solar power, wind power, hydroelectricity and other forms of power, so long as they are renewable. With this variety of power supplies going through one company, we were able to ask for comparison on the costs of each different power source. Through Amerigreen we were able to affirm that currently biomass based fuels are perfectly viable alternatives to more common renewables in that they are able to give similar kilowatt hour yields.
at the same competitive costs of wind and solar. These costs can be managed on account of the reliability of biodigesters—as they can be run regardless of sun and wind conditions—as well as their ability to dispose of waste as a feedstock.

Section 5.3. Opinions on Policies

Of each of the organizations we spoke with, whether they were producers, wholesalers or lobbyists, not a single group was content with the United States policies regarding production and sale of biomass fuels. It was unanimously agreed that the biodiesel blender’s credit—while helpful—was fairly inconvenient. All parties involved agreed that they would much rather receive a producer’s credit instead so that they can get their tax credits without having to go out of their way to purchase domestic or foreign oil or gasoline with which to mix in their product at a mix of one part fossil fuel to ninety-nine parts biodiesel. As a consequence of this blender’s credit, if company wants to take advantage of it, not only must they lose a portion of their profit on buying petroleum or other fossil fuels to mix into their product, but the dependency on foreign products is increased. This appears counter intuitive, as with this dependency the demand for fossil fuels like diesel and petroleum is increased by the manufacturing of renewable biomass fuels, which were developed as a replacement for the very fuel on which they are now reliant. This system of blenders credits expired at the end of 2016, but have often been reinstated. This time, checkoff boards and producers alike are hoping to see tax credits simply for producing their product instead (Banky, Pines, Robinson).

The parties which are directly involved in biomass fuel production and distribution are far from the only ones pushing for beneficial policies. There is a reason that the blenders credits
and road tax breaks for biodiesel, bioheat, and biogas have run to expiration yet been reinstated
time and again in spite of the changing political parties which have been in charge of America.
Biomass fuel has an appeal for everyone: they pave the way for a greener and cleaner future
which attracts Democrats, and they reduce the dependency on foreign oil to appeal to most
members of the Republican party. As such it is incredibly unlikely to find individuals who would
want to lobby against this particular form of renewable energy. This also provides an explanation
to why the field has developed so rapidly: there appears to be nothing to lose and plenty to gain
from continued investment in biomass fuels—especially with the rise and increased development
of advanced biofuels.
Section 6. Conclusion

Most people are aware that continued use of fossil fuel will lead to sustainability problems. As a result of their limited quantities and negative impact on the environment from release of greenhouse gases, they cannot continue to be used as liberally as they are currently. Most people are aware of this and there have been more and more calls to address this growing problem. Many steps have already been taken in an attempt to steadily replace the use of fossil fuels with more sustainable sources. Power companies are required to use renewable power sources for a portion of their power generation, with the penalty of a fine if these specifications are not met. Many alternative forms of energy have been developed to accomplish this goal, such as solar, wind, and hydroelectric power. Despite this, many companies do not meet the requirements, either through inability or of their own volition. The companies that try to meet the specifications, but are unable to do so are hindered by the fines they incur. There are also companies that choose not to use renewable forms of energy as they find continuing to use fossil fuels and paying the resulting fine to be easier and cheaper than constructing the necessary facilities to produce an acceptable form of renewable energy.

It is clearly imperative that the development of biofuels, especially advanced biofuels, be continued. In fact, the only thing holding most people back from transitioning to renewable fuels is the cost. The increasing usage of biofuels has shown to be beneficial to the environment and the economy alike. Unlike with fossil fuels, the burning of biofuels does not add greenhouse gases to the carbon cycle, as the biomass that is used to produce the fuel is a part of the natural cycle. As the pockets of fossil fuels beneath the surface of the Earth continue to be burned up,
not only do they add carbon dioxide to the atmosphere but they become more expensive to locate and unearth. Millions of jobs- including those already dedicated to less sustainable energy production efforts- would be created. People would be needed to construct the proper facilities, to operate and maintain the facilities, to grow, manage and transport the feedstock used to make biofuels, as well as fill various other roles. The number of jobs that already exist due to the biofuel industry proves that many more will be established if the industry is expanded. Yet there are others- still others who stand to benefit from the expansion of the biofuels industry.

One of the reasons that biofuels have not seen the success that other renewable fuel and energy supplies have is that many people think that other forms of alternate energy- particularly solar power- are more convenient, and sufficient for our power needs as a country. These individuals and organizations believe that continued investment in biofuels would take away from these forms of alternative energy and would be a waste of money and resources. However, biofuels do not need to be a replacement for these energy sources. Biofuels do not have to be in direct competition with other alternative energies, but rather can supplement them. In fact, the more developed the industry of biofuel production becomes, the cheaper it becomes, resulting in a lesser impact of the funding of other sustainability efforts. The recent classification of ‘advanced biofuels’ further enhances the field’s ability to coexist with other renewable fuel supplies, as the cost of land allocation is all but negated. In short, biofuels are becoming cheaper and can be developed without the need for additional farmland, and as a result competition with other sustainable energy sources should no longer impede on future investment in the industry.

Biofuels have been remarkable in that they have several other properties which distinguish them from other forms of energy. Biodiesel and other such liquid fuels can be made cheaply just from organic waste products alone, such as unwanted food and inedible plant matter.
Instead of throwing away husks and stalks of corn, scraps of fat from meat, or cooking oil left over from the fryers of fast food restaurants, all such waste products can be carted away to an anaerobic digester to turn what would otherwise be garbage into transport fuel and power. Not only does this result in the generation of clean energy, but also helps to curb the amount of waste that would otherwise be dumped in a landfill. Finding an anaerobic digester to come to such an arrangement is always becoming easier as companies like Newport Biodiesel, Maine Standard and even family owned companies like Pine Island farms happily make contracts for the disposal of the waste product as well.

Additional upsides of biofuel include their ability to be produced independently of environmental conditions. While solar power is dependant on sunlight, geothermal power production on finding pockets of heat from the Earth, and wind power on significant wind flow, provided that biodigesters have their feedstock loaded, they produce power under any conditions. Other considerable advantages include that both major political parties have significant reason to support the development and implementation of biomass fuel. For example, biofuels appeal to democrats due to how their offset of waste food and fossil fuel usage benefit the environment. Republicans, on the other hand enjoy that as biodiesel and ethanol production become more widespread, they contribute to the United States transitioning toward lesser dependence on foreign oil.

Should these advantages not provide incentive enough to invest in the industry, many potential investors find a significant return on investment from biomass fuel. Some businesses find the biofuel industry to be very lucrative, especially given the versatility of biodiesel. This is evidenced by the fact that many biofuel producers begin as home heating businesses, not unlike Newport Biodiesel (Robinson). There are also individuals such as Charles Vigliotti, referred to
as “The Compost King of New York” in an article by the New York Times by the same name published on February 15th of 2017, who quite happily admit that their involvement in the biomass fuel industry stems from economic interest alone. Viliotti founded American Organic Energy and is hoping to break ground on a new anaerobic digester soon. He is so committed to this endeavor that he has already contracted several producers of organic waste such as supermarkets to build up a large feedstock.

Of course, those that stand to gain the most from biofuels becoming more mainstream are the biofuels producers themselves, and as such they have the most to say on the subject. Many producers are unhappy with the amount of support that biofuels currently receive and have strong opinions on how to improve it. One thing that producers would like to see implemented is a tax credit specifically for companies that produce biofuels, rather than the systems currently in place. While the blender’s credit that exists can be taken advantage of by biofuel producers who buy natural gas and other such fossil fuels to mix with their product, it makes much more sense to simply implement a tax credit to benefit said producers instead. The blender’s credit may have benefitted the industry in its early stages of development, but if it is intended to support the production of biofuels, it would be significantly more beneficial to producers if they received said tax credits simply for production. Every subject interviewed in this study stated that this would allow producers to receive similar benefits as producers of conventional fuels, without being required to purchase gasoline or diesel to mix with the biofuel they make. As such, it was unanimously agreed that a new system of credits such as this would lead to a significant push forward for the biofuel industry, particularly for biodiesel.

There is however, the problem that resources needed for the production of biofuels are currently somewhat limited. One thing that biofuel producers would like to see in order to
improve this is an increase in recycling. As previously mentioned, the production of biofuels is heavily dependent on waste products. With the vast amounts of waste that is produced in the United States, a significant amount of waste product could be obtained with relative ease. Unfortunately, the percentage of waste products recycled in the United States is significantly lower than countries such as those in Europe. If the rate of recycling in the United States were to increase, there would be more resources available for use in the production of biofuels. This would in turn allow further development of the industry without the need of dedicating additional funding to research in the field. Fortunately, with the introduction of waste disposal bans in states like Massachusetts, some biofuel producers have been able to obtain materials to use in their biodigesters more easily. In fact, often companies with waste production exceeding the amount specified by the waste bans- frequently restaurants, colleges, prisons and supermarkets- will happily contract biofuel producers to get rid of the waste for them. This results in a symbiotic relationship between these businesses, allowing both to benefit. As these bans and other such methods of incentivising recycling become more widespread, it will become much easier and cheaper for producers to obtain the feedstocks they need to keep their facilities running.

Some of the issues from this problem can be mitigated through making the most out of recycled waste and other feedstocks, however. Recently, the South Carolina Soybean Board discovered that the oil in soybeans can be extracted, leaving the meal behind. Previously, soybeans were required either to be used as food for livestock or as fuel to be used in biodigesters. Now, thanks to the discovery of the SCBB and other soybean farmers, soybeans can be separated into solid and liquid components and used for both purposes. This raises the limits of how much edible feedstock can be dedicated to biofuel production. Similarly, Pine
Island Farms found that manure can be separated into liquid and solids parts, which are used in the company’s anaerobic digester and as fertilizer respectively. Discoveries such as these have led to an increase in efficiency for producers across the country, and should it be discovered that similar strategies can be applied to other feedstocks, then it is likely that biomass fuels will be able to continue their rapid rate of development.

Biofuels have great potential to bolster the supply of renewable energy within the industry of transport fuels and power grid. Unfortunately, the use of fossil fuels is so ingrained in our infrastructure that there is not much incentive for companies to use biofuels in the production of power. In order to increase the prevalence of biomass fuels as a transport fuel and power source, many changes must be made. Biofuel producers should be allowed to receive more benefits for their work, and to incentivise the growth of the industry, we believe that these credits must match the benefits gasoline producers take advantage of as closely as possible. For example instead of the blender’s credit, there should instead be a producer’s credit. Furthermore, research into the extraction of the oil in feedstocks should be advocated to continue to increase the number of feedstocks whose efficiency can effectively be doubled by biomass fuel production and consumption. Of course, people should always be encouraged to recycle as much as possible, so that any biomass waste can be used by biofuel producers. Also, much more federal funding and research should be dedicated to the development and production of second generation biofuels. The implementation of second generation biofuels would alleviate many of the issues of first generation fuels, such as additional land allocation. Lastly, research into how biofuels can be used to produce energy, as opposed to being used solely as a liquid transport fuel, would be incredibly beneficial to the electrical power infrastructure. Given continued investment, attention and time biofuels could develop into a field as efficient and lucrative as
other renewable power sources with the added advantages of their independance on environmental factors and ability to double as a means of waste disposal.
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