Biofuel Produced from Algae

Eliminating the need to subsidize fuel from corn ethanol; leaving corn to be utilized as a much needed food source for the expanding population

Tag Words: Biofuels, Algal Fuels, Microalgae, Fuel Subsidies, Renewable Energy

Authors: Andrew Rysanek and Julie M. Fagan, Ph.D.

Summary:
Unlike the highly subsidized fuels produced from corn that affect food prices and availability, biofuel produced from algae is both cost efficient and simple to produce. Only three things are needed to grow algae: light, water, and carbon dioxide, and they generate mainly glucose and lipids as byproducts. The oil produced is then extracted and easily converted to biodiesel by mixing the oil with methoxide, which separates the oil into two layers, the top layer being biodiesel and the bottom layer being glycerin, itself a useful commodity which can be sold to other manufacturers, partially covering the costs of production. Oil algae also produces sugars that can also be fermented to produce bioethanol. The video demonstrates the basics of making biodiesel at home. In this instance, oil was extracted from dry microalgae biomass with the use of a simple garlic press until 1 liter of oil was extracted.

Video Link: https://youtu.be/YuuDPsoRaNM

Unsustainable methods for sustainable energy

Biofuels are of great importance in our efforts to find a sustainable and renewable fuel source for the future as our energy needs continue to grow at a time where it is more important than ever to consider environmental concerns. However, the consequences of subsidizing farmers who normally grow food crops in order to incentivize them to grow corn and sugarcane for biofuel has a great impact on food prices and availability, and these fuels have not shown to be the most sustainable and efficient biofuels. Furthermore, on a broader scale, subsidies in the overall energy market are also a hindrance to sustainable energy, as they create various market distortions and inefficiencies which prevent alternative fuels from penetrating and competing on the energy market. Research currently indicates that a biofuel industry based on tax credits and subsidies is an unsustainable method for finding sustainable energy.

The importance of renewable energy cannot be understated. There is a growing sense of urgency regarding the future of the energy industry. It is generally understood that our dependence on fossil fuels as our primary fuel source cannot continue much longer. Though these fuels provide tremendous energy, they are in a finite and diminishing supply, and a major contributor to growing environmental problems like pollution and climate change. Biofuels are an exciting and realistic solution to these problems. It is not a question of “If”, but rather “How” we should achieve success with biofuels. Should we sacrifice food crops for fuel? Should the government incentivize farmers to do so? Should the government be involved at all? What biofuel is best? In
this proposal, we will first examine the effects of biofuel subsidies, energy subsidies the efficiency of biofuels, and discuss how algal biofuels eliminate the need for food crop biofuels and subsidies in the industry. Microalgae biofuels have shown great potential; requiring far less essential resources to produce a clean renewable fuel, while at the same time, creating significant opportunities for private industry in terms of competition and profitability.

Effects of Biofuel Subsidies

Rise of Inefficient Industry

There been few instances in the Unites States where an entire industry has emerged as quickly as that of ethanol. The U.S. began subsidizing ethanol in the 1980’s, and have been fostering the industry increasingly to the point where in the past 7 years as much as 40% of corn grown in the United States went to ethanol production. Aside from having 40% less corn available for food and livestock feed, the ethanol subsidy removes farmers (suppliers) from the industry. In terms of sustainability, corn ethanol ranks very low, as its yields are among the poorest of all biofuels. Since the demand for corn remains the same, this leads to a rise in price. Furthermore, incentivizing ethanol production has other less obvious and unintended consequences on tax revenue.

Abuse of Tax Credits

Additionally, tax credit programs designed to increase ethanol production have been taken advantage of. One such credit is The Alcohol Fuel Credit, which “provides qualified producers with tax credit worth 10 cent per gallon of ethanol. To be eligible, the ethanol producer must have productive capacity less than 60 million gallons per year with the credit being applied to the first 15 million gallons.” This credit was intended to help smaller ethanol producers. However, the pulp and paper industry took advantage of this credit by applying it to a mixture of black liquor which is used during the production of their products. As a result, those industries received an estimated $4 billion in tax credits in the year 2009 alone. Ethanol tax credits are simultaneously raising food prices, reducing suppliers, and eliminating valuable tax revenue.

Diverting Resources

In general, subsidies distort the economy by diverting market resources and capital from one area of the market to another, in a way which would not happen if these sectors were left alone. This often leads to a removal of resources from more productive areas of capital goods which are then funneled into less productive and inefficient areas in order to “prop up” an industry. This is precisely what we are seeing in the biofuel industry. Biofuels that are so grossly inefficient that they would have never lasted this long without subsidy are continuing to receive the benefits of taxpayer money, keeping them afloat even though they are not commercially viable, energy efficient, or environmentally sustainable.

Hindering Innovation
Another effect that subsidy has on technology which is often neglected is its effect on new innovation. Many promote subsidies as a springboard for innovation. However, it is very often just the opposite. For example, when governments diverted billions of dollars in an effort to foster the civilian nuclear power industry, there was an overwhelming tendency to stick with the original technological designs, rather than improve on them. This situation arises when you don’t have to worry about being self-sufficient, and thus cutting costs while increasing output are not a concern and further still, innovations which will increase efficiency and achieve the aforementioned goals will not come to fruition. The situation with corn-based ethanol production in the United States comes with similar consequences, not only for the energy market, but the food market as well. As noted by the International Institute for Sustainable Development, even if the costs of making corn ethanol from feedstock fall, “the dominant feedstock will likely remain corn (maize) for many years to come.”

Ending Fuel Subsidies as Part of the Solution
The New Zealand Model

Though it may seem like a move in the opposite direction, ending government subsidies of energy may lead to a quicker solution. Subsidies can and do lead to inefficiency and in some cases slow or halt progress entirely. One such example is in the Farming industry in New Zealand. New Zealand ended all agricultural subsidies in 1984. This was extremely radical at the time because New Zealand is roughly 4 times as dependent on its farming industry as the Unites States is. However, the farming industry has thrived since subsidies ended. This happens because without subsidies, farmers are faced with pure competition and forced to diversify land use, develop niche markets, and increase overall efficiency. Official figures show that farmers in New Zealand are the “least subsidized and most productive among the countries in the Organization for Economic Cooperation and Development.”

Since the subsidy removal, New Zealand’s farm sector has grown by 40%, and according to The Federated Farmers of New Zealand has “thoroughly debunked the myth that the farming sector and the environment cannot remain healthy and prosper without government subsides.” They have also seen a rise in the contribution of the agricultural sector to the GDP from 14.2% to 20% since the removal, which has shown to be “a catalyst for productivity gains” in the agricultural sector.

New Zealand has also seen environmental improvements since the removal of farm subsidies, particularly an improvement in water quality. This is due in large part because part of what farmers did to cut costs and improving efficiency after subsidies stopped is develop a more targeted approach to the use of chemicals and fertilizers, which they can no longer continue to use haphazardly.

Proposal for the United States

This proposal urges that the United States adopt this approach with regards to its energy sector. We too can see immediate benefits, both environmental and economic, with the removal of energy subsidies. The potential for waste reduction, increased efficiency, environmental improvement, and stabilization of the energy market is tremendous. It will not only improve
energy output and efficiency, but will help lead to new innovations in energy technology by allowing the market to direct capital to energy technologies which are viable and sustainable. This is in contrast to the status quo, which for the better part of a century has been to heavily subsidize oil and petroleum fuels in an effort to keep fuel prices artificially low. This has led to an ever-increasing dependence on fossil fuels at the expense of both the environment and the taxpayer.

More recently, this same approach has been applied in an attempt to foster the biofuel industry which has led to gross misallocation of capital, energy, and food resources. In short, we need an economically sustainable solution in order to achieve sustainable energy. Any other approach is inherently counterproductive.

**Return Energy Market to Stability**

Without subsidies from the taxpayer, inefficient biofuels will fall out of favor. Farmers who are growing corn and sugarcane for ethanol will return to growing food crops which will in turn lower food prices, increase availability of food, and allow companies making truly efficient biofuels to compete fairly on the energy market. Ending fuel subsidies altogether will also level the playing field for efficient biofuels to compete with the ever-depleting fossil fuels, which are themselves heavily subsidized.

Roughly 60% of all energy subsidies in the United States go toward keeping petroleum fuel prices artificially low. As recently as July of 2014, Oil Change International estimated the total U.S. investment in fossil fuel subsidies to be $37.5 billion annually. This type of major government subsidies creates massive distortions in the energy market, eliminates honest pricing, and keeps alternative fuels from competing in or even penetrating the energy market. Without fuel subsidies the cost for one gallon of gasoline would be approximately $12.75. It quickly becomes clear that if energy subsidies are removed and petroleum fuels are allowed to rise to their true market price, the demand for alternative fuels would rise dramatically, making cost-efficient biofuels increasingly viable.

Current estimates from the Algae Biomass Organization project a cost of algal biofuel to be between $3 and $5 per gallon. This price will only fall as demand rises and production is increased as more companies enter the algal fuel market to meet growing demands. As more companies emerge, competition between them will force the companies to produce a quality fuel in the most cost-effective and efficient way possible.

**Biofuels from Microalgae are a Real and Efficient Alternative for Today’s Energy Needs**

**Commercial Viability**

If energy subsidies are removed, people will understandably have concerns regarding the ability of alternative fuels to develop and compete. Subsidy removal will level the playing field. This will allow the most efficient and commercially viable alternative fuel to rise above the competition and establish a foothold in the energy market. Currently, this is undeniably algal biofuel. The potential for microalgae biofuels as the fuel for the future cannot be understated. Certain strains are as high as 70% in lipid content and methods for oil extraction are relatively
simple. It is not surprising that scientists are turning to microalgae as an energy source given its potential yields and general consensus to be the precursor to the world’s fossil fuels.

Using microalgae will not affect food prices and availability, and can be done using far less land resources as they are typically grown in open or closed man-made pond systems. Furthermore, they remove carbon from the air during photosynthesis and thus have the potential to “clean up” some of our pollution problem as they are a net zero carbon emission fuel. In fact, close proximity to a petroleum fuel plant would be an ideal location for an open pond algae farm as the carbon emissions from the power plant would help spur further growth of the algal pond.

**Cost and Efficiency of Production**

Part of what makes algal biofuel so cost efficient is the relative simplicity of its production. Algae are highly abundant aquatic organisms. They are autotrophic, and carry out photosynthesis along with carbon fixation for energy. During this process, the algae utilize chlorophyll pigment, contained in organelles called chloroplasts, to capture energy from sunlight. During this process several byproducts are formed, mainly glucose and lipids. In short, only three things are needed to grow algae: light, water, and carbon dioxide. The oil produced is then extracted and easily converted to biodiesel by mixing the oil with methoxide, which separates the oil into two layers, the top layer being biodiesel and the bottom layer being glycerin, itself a useful commodity which can be sold to other manufacturers, partially covering the costs of production. Furthermore, besides oil, algae also produce sugars which can be fermented to produce bioethanol.

**Growing Options**

Currently, microalgae can be farmed on a mass scale in either open pond, or closed-pond systems. Open ponds are large outdoor pools where microalgae are grown and cultivated and generally provide the highest yield. However, this particular system is more susceptible to contamination and therefore is best for dryer climates like that of the American Southwest. Closed pond systems consist of indoor photo bioreactors which typically do not have the yields of open ponds but hold several distinct advantages. The environment is much more controlled and thus minimizes the risk of contamination. In addition, photo bioreactors give the producer more of a choice on which strain can be used during production, as typically in open pond systems you are limited to strains relatively local to the area and therefore more resistant to contamination, but not always of the highest lipid content.

**Microalgae biofuels present legitimate competition for fossil fuels and natural gas**

**Advantages of Supply**

Unlike fossil fuels, and even other biofuels, where there is a concern for energy demand exceeding energy supply, the use of microalgae as an energy source is far less of a concern. Many species of microalgae are more than 50% rich in the necessary lipids to be used for fuel, and many can as much as quadruple in biomass in a 24 hour period. The U.S. Department of energy has estimated that it would only take about 15,000 square miles of land in order to replace...
all petroleum products in the United States, or roughly 0.5% the land mass of the United States. If producers were to increase areas of production to 1% the land mass of the United States this would additionally open up opportunities for fuel exports. Microalgae rely less on seasonal variances than other agriculture and require far less fresh water. This makes algae a renewable, sustainable, and viable alternative fuel.

Wastewater Integration

Algae are already used in the wastewater treatment industry. Construction of high rate algal ponds (HRAP) has already been completed and utilized to treat wastewater. These ponds utilize algal photosynthetic energy and provided oxygen to “drive aerobic bacterial degradation of organic compounds. The wastewater nutrients that are released are, in turn, assimilated into algal biomass” This presents an economic opportunity as the biomass is a byproduct of the wastewater treatment process. This “free” biomass could then be utilized for biofuel production. The costs associated with the production and harvest of algal biomass would be virtually covered by the wastewater treatment enterprise, cutting costs and therefore lowering the price of the resulting biofuel.

Current Applications

Algae biofuels have already demonstrated that they are a direct substitute for fossil fuels and natural gas. They have successfully been used to power commercial flights, cars, motorcycles, generators, houses, and virtually anything else run on today’s fuels. The relative ease of production versus the potential of virtually unlimited demand means an incredible opportunity for success for companies who produce these fuels.

Investors are beginning to realize the potential of algal biofuels as the fuel of the future. In February of 2014, an Indian oil holding company, Reliance Industrial Investments, placed a purchase order for $2.4 million with Algae Tec, an Australian algal fuel company, making their third such investment in algal biofuels. Other investments include $93.5 million in Algenol and $22.5 million in Aurora Algae. This comes one year after Synthetic Genomics announced a partnership with ExxonMobil to develop algal biofuels with an initial budget of $500 million.

With growing concern over the future of our planet by the public, and growing concern over the financial future of their companies by those in big oil, it is not surprising to see these types of partnerships emerging. As petroleum fuel resources become scarcer, we can expect to see more oil companies investing in alternative fuels. Clearly, removing energy subsidies will act as a catalyst for these partnerships, and for the emergence of efficient biofuels.

Community Action: Demonstrating the ease of producing Biofuel from Algae

A video showing the basics of producing biodiesel in the home was uploaded onto YouTube on Dec. 9, 2014 and was viewed by 455 individuals before replacing the video with an improved one on Feb 23, 2015. This second version, which received 78 views, was not viewable in certain countries due to the choice of music (copyright violation) and was replaced with a 3rd video uploaded on 3/30/2015 free of copyright violation.
The first video was sent out to Interactive Sites For Education, and Try Science.org, which are websites that focus on science education through video demonstrations. The second (and third) improved video uploaded onto YouTube in Feb 2015 (and Mar 2015) included, in addition to the demonstration of how to produce biodiesel from algae at home, the recipe for doing so and an introduction on how biofuel produced from algae is a sustainable source of alternative energy. The third version of the video [https://youtu.be/YuuDPsoRaNM](https://youtu.be/YuuDPsoRaNM) was sent to xxxxxxxxxxxxxxx (see cover letter below).

It is hoped that by reaching out to a variety of online educational resources, that people will consider taking energy solutions into their own hands. Relying on each other, rather than government, will prove to be the best and most sustainable way to solve our energy needs for the future.

References

3. Ibid, 36.
6. Ibid.
9. Ibid.
10. Ibid.
Sent to: Algae Industry Magazine
To Whom It May Concern,

With growing concern over the future of sustainable energy, I, like many, am excited about the potential of algal biofuels. I believe they are of immediate importance as well as a long term solution to our energy needs. The question is not should we, but how are we going to get algal fuels competitive in the energy market.

Recently, an article from the National Algae Association was posted on algaeindustrymagazine.com calling for a “Manhattan Project” for algal biofuels, a collaborative effort between government and private industry with a goal toward the advancement of algae-based biofuel. I believe this would be a counterproductive move and not the fastest, best, or most efficient way for algal fuels to compete. Instead, I would propose the government stay out of the energy market entirely, and end energy subsidies all together.

Consider that currently the U.S. is subsidizing fossil fuels to the tune of approximately $37.5 billion according to Oil Change International estimates. These subsidies keep the price of petroleum fuels artificially low and thus prevent legitimate competition from alternative fuels. If the U.S. were to stop subsidizing energy entirely, gas prices would rise to approximately $12.75 a gallon. In such a situation, there would be no need for government to incentivize companies to create alternative fuels as a tremendous demand for alternatives would quickly arise. We would see more companies investing in biofuels, and the number of producers would increase. I have no doubt that algal biofuels would quickly emerge in such an unsubsidized market due to their relative simplicity of production, and greatly reduced need for land resources coupled with superior yields when compared to the production of other biofuels.

In short, we need an economically sustainable solution to sustainable energy. The removal of energy subsidies presents the best, and most economically sound route toward achieving this goal. The ones who would be most negatively affected by this would be the big oil companies, who would themselves be forced to look into alternatives in order to remain viable. I strongly urge all those who support alternative and sustainable energy solutions to push for energy subsidy removal.

Sincerely,
Andrew Rysanek