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Biodiesel - Algae

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Abstract

In the past century, fossil fuels have served us a cheap and effective source of energy. Now that we are running out of fossil fuels, and we are becoming more aware of the environmental consequences of their emissions, biofuels are emerging as an appealing alternative source for the future. Especially with recent breakthroughs involving algae as a possible source for biodiesel production, many companies are looking to invest in algae-to-biodiesel technologies. This study investigates how algae can be incorporated as a significant part of US energy solutions. Specifically, we found two promising avenues for advancing algae biofuel prospects in today's society: co-production coal-burning plants, and cultivation in conjunction with sewage treatment.

Problem

Ever since the industrial revolution mankind has had a voracious appetite for energy. Many types of alternative energy were introduced to the world. The problems of other alternative energies are their price and their emissions.

The US is still dependent on fossil fuels. The US has looked into using many different types of alternatives, but none have been found to have any significant impact.

Algae for Biodiesel

In comparison to traditional oil-seed crops, algae yields much more oil per acre. While soybean typically produces less than 50 gallon of oil per acre and rapeseed generates less than 130 gallon per acre, algae can yield up to 10,000 gallons of diesel per acre. In particular diatoms and green algae are good sources for the production of biodiesel.

FUEL SOURCES

CROP	USED TO PRODUCE	GREENHOUSE GAS EMISSIONS* Kilograms of carbon dioxide created per mega joule of energy produced	USE OF RESOURCES DURING GROWING, HARVESTING AND REFINING OF FUEL: WATER	FERTILIZER	PESTICIDE	ENERGY	PERCENT OF EXISTING U.S. CROP LAND NEEDED TO PRODUCE ENOUGH FUEL TO MEET HALF OF U.S. DEMAND	PROS AND CONS
Corn	Ethanol	81-85	high	high	high	high	157%-262%	Technology ready and relatively cheap, reduces food supply
Sugar cane	Ethanol	4-12	high	high	med	med	46-57	Technology ready, limited as to where will grow
Switch grass	Ethanol	-24	med-low	low	low	low	60-108	Won't compete with food crops, technology not ready
Wood residue	Ethanol, biodiesel	N/A	med	low	low	low	150-250	Uses timber waste and other debris, technology not fully ready
Soybeans	Biodiesel	49	high	low-med	med	med-low	180-240	Technology ready, reduces food supply
Rapeseed, canola	Biodiesel	37	high	med	med	med-low	30	Technology ready, reduces food supply
Algae	Biodiesel	-183	med	low	low	high	1-2	Potential for huge production levels, technology not ready

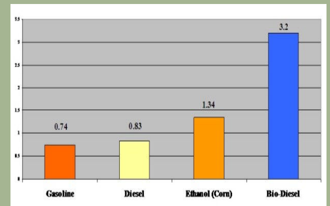
* Emissions produced during the growing, harvesting, refining and burning of fuel. Gasoline is 94, diesel is 83.

Source: Martha Groom, University of Washington; Elizabeth Gray, The Nature Conservancy; Patricia Townsend, University of Washington; as published in Conservation Biology SEATTLE P-I

In mid 2007 there were 3 companies developing bioreactor technologies to produces biodiesel from algae. They were Greenfuel Technologies, Solix Biofuels, and PetroSun. However, there was a 1998 program that investigated the production of biodiesel from algae grown in ponds utilizing the waste CO_2 from coal-fired plants. They found that some species were able to grow under extreme conditions of temperature, pH, and salinity. They developed a large surface area of 1000m² capable of unitizing 90% of the CO_2 being put into the system. Despite all of the benefits and good findings from this test, they found it would be too expensive to make biodiesel algae on a large scale. It was around $69 per barrel for biodiesel algae, while oil was less than $20 per barrel then. However since 2000, oil prices have tripled and quadrupled, leading to biodiesel algae as a very plausible option.

Biodiesel

The majority of biodiesel production in the U.S. is from soybean oil, unlike Europe which uses mostly rapeseed due to their colder climate. There are 165 operational sites with a capacity of 1.85 million gallons per year. New plants are under construction which will add another 1.37 billion gallons per year. Some of these sites will be capable of producing 100 million gallons alone. It is estimated that biodiesel can yield 3.2 units of fuel product for every unit of energy off fossil fuel used to create it. Conventional diesel yields about 0.83 units of energy per unit of fossil fuel consumed. This shows undoubtedly that biodiesel fuels are much more efficient than regular diesel.



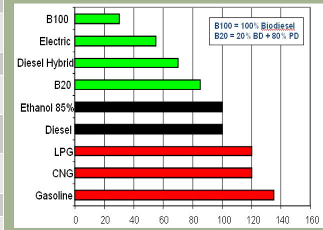
For every unit of fossil energy used in the entire bio-diesel production cycle, 3.2 units of energy are gained when the fuel is burned, or a positive energy balance of 320 percent.

A study conducted by the Renewable Energy Laboratory concluded that B100 reduced CO_2 emissions by 74.5%, B20 reduced it by 15.7%. B100 completely reduces tailpipe emissions of sulfur oxides, it also reduced sulfur oxides 35%, CO 32%, and total particulate matter by 8%. However, NO_x emissions as well as hydrocarbons were slightly increased with the use of B100.

AVERAGE BIODIESEL EMISSIONS COMPARED TO CONVENTIONAL DIESEL, ACCORDING TO EPA

Emission Type	B100	B20
Total Unburned Hydrocarbons	-67%	-20%
Carbon Monoxide	-48%	-12%
Particulate Matter	-47%	-12%
NO_x	+10%	+2% to -2%
Sulfates	-100%	-20%
PAH (Polycyclic Aromatic Hydrocarbons)	-80%	-13%
nPAH (nitrated PAH's)	-90%	-50%
Ozone potential of speciated HC	-50%	-10%

Relative Greenhouse Gas Emissions

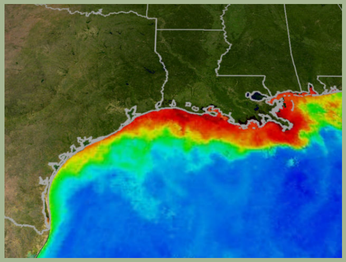


Results and findings

There are two ways algae farms can be incorporated in the United States, each with its own benefits.

Algae farm/Coal plant – Build algae farms next to coal plants and have the carbon dioxide emitted from the coal plants be used to feed algae in the algae pond next to it. You would then use the energy produced by the coal plant to maintain and harvest algae and then derive biodiesel from it. This plan would be especially effective if government is to pass a cap and trade policy for carbon dioxide, which would really encourage coal power plants to invest in algae ponds.

Algae farm/Sewage treatment – Build an algae farm with duel purposes in mind. Have the algae biologically clean sewage water of excess nutrients such as phosphates and nitrates, as it uses them to rapidly bloom. This plan could be very effective for building algae plants near cities, and have the plant both provide power to the city as well as clean its sewage.



The red area - The Gulf of Mexico Dead Zone

Dead Zone – The Gulf of Mexico has huge potential for algae growth. Tons of excess nutrients are released into the Gulf at the Mississippi delta, because the Mississippi river runs through many agricultural states that use a lot of fertilizer, for growing crops. This sight has the potential of being as significant as the Hoover dam is in scope of hydropower. Currently this area is referred to as the Dead Zone, because seasonal algae blooms choke of the water of dissolved oxygen making it inhabitable for most organisms