Carbon Dioxide: A Renewable Resource?

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Outline

I. Los Angeles air quality is unacceptable, and algae can help solve this problem.
Carbon dioxide can be a renewable resource when paired with algae to help reduce the amount of air pollution.

II. Body
    a. Smog
        i. Types of air pollution.
        ii. People affected by the pollution.
    b. Algae
        i. Algae lamps
        ii. Microalgae biofuel factory.
    c. Companies that work with algae biofuel.
        i. Natural Resource Energy Lab.
            1. Open ponds
            2. Photobioreactors
        ii. Joule Unlimited.
            1. Genetically altering algae
            2. Factories are compact, not using much land
    d. Pro/con on these company's methods.
        i. Cyanobacteria poisonous to animals and humans
        ii. Power and water expense

III. Benefits of using algae to clean the air, while getting biofuel
Citizens in Los Angeles would breathe better if algae lamps and biofuel factories were installed.

Picture smog-filled cities being pollution free, while producing clean biofuel and oxygen; highly polluted areas, such as the Los Angeles area, pose a threat to the elderly, children, and people suffering with Chronic Obstructive Pulmonary Disease (COPD) ("People at Risk," 2013). Algae can be used to harness the carbon dioxide, nitrogen, make oxygen and be refined for biofuel. A cyanobacterium is the most common type of microalgae used for biofuel ("Massachusetts Company Making," 2011). The biofuel from algae can be cost effective, only costing $10 to $20 a barrel to produce. However, there are still financial set-backs to the algae biofuel market (Pienkos, Laurens, & Aden, 2011). A French scientist has even invented a lamp of algae, which runs off carbon dioxide and produces oxygen ("Large Scale Algae Street Lamps to Clean the Air off its CO2 content," 2012). Two companies are researching microalgae biofuel production: Joule Unlimited and the Natural Resource Energy Lab. Methods for finding other strands of microalgae biofuel include natural trial and error testing and genetic engineering (Pienkos, et al., 2011). "Algae lamps" and microalgae biofuel are some tools Los Angeles can use to clean their air.

Over 130 million people live in areas where the quality of air is unhealthy ("Key Findings," 2013). Smog is characterized into two types: inversion and photochemical. Inversion smog happens when the air becomes unmoving, which makes the smog into a poisonous, deadly cloud. Photochemical smog is a chemical reaction between car exhaust, ozone and sunlight, turning the car exhaust into "formaldehyde" ("Air pollution and pollutants: Anthropogenic," 2010, p. 24). The American Lung Association (ALA) rates cities' pollution, based on "particle or ozone pollution" and short/long-term ("Key Findings," 2013). Particle

pollution is classified as being “soot, fly ash, or any other small particle that can be suspended in the air” (“Air pollution and pollutants: Anthropogenic,” 2010, p. 24). The Los Angeles, Long Beach, and Riverside, California, are the cities with the lowest grade on air quality with an “F” in all categories. As many as 18,000,000 people live in these areas, and 500,000 of them suffer with COPD. Also, 4% of the population has cardiovascular disease in this area, compared to 1% in Montgomery, Alabama, which was graded a “B” on air quality (“Compare Your Air,” 2013). Air pollution is not healthy for any person, but the people at the greater risk are the elderly, people with COPD, cardiovascular disease, and children. Los Angeles' area residents are living in constant unhealthy air conditions, which can be detrimental to anyone with vascular or respiratory disorders.

Algae can help lower the amount of carbon dioxide in Los Angeles. The first method consumes carbon dioxide to produce oxygen and light. Pierre Calleja, a French biochemist, has created what he calls an “algae lamp” (“Large Scale Algae Street,” 2012). The lamp can function day or night, using photosynthesis and carbon dioxide to light streets. These lamps consume one ton of carbon dioxide a year. Most of the pollution comes from cars, thus Pierre installs his lights along roadways (“Large scale Algae Street,” 2012). These lamps could be installed along all the major roads in the Los Angeles area. Algae lamps would lower carbon dioxide amounts and distribute oxygen.

Unlike the “algae lamp,” the next method uses carbon dioxide, not just oxygen, to help feed algae for biofuel. Not just any algae will work; microalgae or “unicellular photosynthetic microorganisms are the perfect source for the fats used for oil (Pienkos, et al, 2011). Biofuel

factories need to be in an area where they can attract the most carbon dioxide. The best area for a microalgae biofuel factory would have to be somewhere dry, hot, with plenty of sunshine. The production of biofuel from microalgae takes a steady supply of water; algae can grow in any type of water (Borowitzka & Moheimani, 2013, pp. 14-15). Microalgae biofuel is referred to as "cellulosic" because it is a cellular being ("Domestic Renewable Fuels," 2013). Once microalgae multiply, the end result is called biomass. Scientist treats the biomass with chemicals, then press the biomass until no water remains. Methane is produced by "anaerobic" (requiring no oxygen) digestion of the carbohydrate, while ethanol comes from the carbohydrate fermentation process. Proteins left over are used in animal feed (Pienkos, et al., 2011). Microalgae biofuel manufacturing takes plenty of land, steady flow of water, and biomass.

Companies are currently testing multiple systems of microalgae manufacturing. Natural Resource Energy Lab (NREL) is currently testing different strands of algae, in order to find the one with the most fats. They are also working of different systems to make cultivation cost effective. *Photobioreactors* are systems of closed clear tubing; these systems are great for controlling the atmosphere for the microalgae ("Cultivation of Algae," 2014). Open ponds are the most common type of cultivation. Open ponds do not have to be very deep and can be lined with thick plastic. They have to utilize some type of wheel to keep the water mixed so that all the algae get adequate sunlight (Pienkos, et al., 2011). NREL has found that the best algae for producing biofuel are the green algae referred to as oleaginous (oily). This alga is favorable due to its ability to make abundant oil (Randakovits, Jinkerson, Fuerstenberg, Tae, Settlage, Boore, & Posewitz, 2012). The NREL is currently trying to find the best method to make

microalgae biofuel affordable without sacrificing oil content.

Joule Unlimited, a Massachusetts biotechnology company, has been studying ways to manipulate genes in algae to produce biofuel. The main strand of algae they use is the cyanobacteria strand because it is easy to manipulate the genes. They have produced an organism that discharges diesel fuel with only sun, carbon dioxide, and water ("Massachusetts Company Making Diesel," 2011). Joule Unlimited has taken away the hassle of biomass. The system they use has cyanobacteria that turn the carbon dioxide into useable fuel. Joule's system can be placed on "100 to 1000 acres of land," unlike the traditional method that calls for a great amount of land ("About Joule," 2014). Joule Unlimited and The National Resource Energy lab both are making strides in how microalgae biofuel is produced.

Production of algae biofuel from either genetically modifying algae or fermentation each has issues; for example, cyanobacteria are extremely poisonous to animals and humans. Also, it can drain all the nitrogen from the water, causing massive fish kills (Rodgers, 2010). Joule Unlimited would have to safeguard to make sure safety precautions were being met. The Natural Resource Energy Lab's method is not without error either. The open pond method leaves the water uncovered; this creates a problem for insects and weeds to mess up the crop. The photobioreactors are very expensive to operate because of chemical balances and amount of power needed to power them. These chemical balances are mainly nitrogen, which cost the most to regulate (Borowitzka & Moheimani, 2013, pp. 17-18). Phillip Pienkos, a scientist from NREL, stated in an interview with the *Gainesville Sun* that he believes Joule has traded one problem for another. He reviewed Joule's latest reports, which showed mostly water and a little

fuel (“Massachusetts Company Making,” 2011). Both companies equally have problems; however, Joule seems to have the least amount of them.

Algae lamps and biofuel are both ways to combat air pollution in Los Angeles. The amount of pollution in Los Angeles and the cities around it could lead to breathing problems. Something needs to be done to turn that carbon dioxide into a renewable resource. The Natural Resource Energy Lab and Joule Unlimited are two companies making advancements in researching algae biofuel. Algae lamps would be efficient for the sidewalks and the areas around big smog-pouring factories. They would help absorb some of the carbon dioxide and provide oxygen. There is not an exact estimation to what an “algae lamp” costs, though. Open pond and photobioreactors are the two types of non-genetic microalgae biofuel options. However, it’s safe to say that more of Los Angeles’ citizens would breathe better if “algae lamps” and Joule Unlimited factories were added to the outskirts of the city.

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