Alternative Fuels for Vehicles

An overview of various approaches for reducing greenhouse gas emission and ending oil dependence

Tag words: biofuel; biodiesel; biogasoline; bioethanol; carbon capturing; carbon neutral; energy carrier; energy density; energy source; fuel efficiency; hybrid vehicles; hydrogen fuel cells

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Summary:

In this project, we address the issues of using petroleum products to fuel vehicles and talk about other alternative fuel options. The main problem with using petroleum is the CO2 emission, which cause global warming, an effect that can have devastating impact on every life form on this planet. Another issue with dependence on petroleum is the economic and political instability it causes. Many alternatives are proposed, some are being carried out; but they have strengths and weaknesses. Hydrogen fuel cells, while can power car without releasing greenhouse gases, are hard to produced efficiently without using fossil fuels. Electricity is very efficient in powering vehicles but it faces major difficulties in making batteries at substantial quality. Ethanol is an energy carrier for the Sun, theoretically it can be carbon neutral but the production of ethanol is not efficient, making it a less viable choice. Natural gas is an abundant energy source but nonetheless limited and not carbon neutral. Algal biofuel, on the other hand can be carbon neutral and also very efficient to produce. Hence, we conclude that algal biofuel is the most promising fuel for vehicles in the near future. However, further research is necessary before algae can be used to replace petroleum. To promote algae researches, we want to ask the coal industry to use algae to reduce their CO2 emission. If this is carried out, it will direct more attention toward algae and also helps reduce CO2 emission. (VN)

Video link: http://www.youtube.com/watch?v=o-FjWsPZ_9o&feature=youtu.be

I. The negative effects of oil:

CO2 emission:
CO2 emission has become more and more of an issue in the past few decades. CO2, the greenhouse gas, has risen to 394.45 ppm in 2012, which is much higher than that in the late 19th century (290ppm). The mean global temperature now is at 14.5°C, which is the highest in hundreds, many thousands of years. Global warming is a fact. So, why is the CO2 level so high right now?

There are many sources of CO2. Naturally, the source of CO2 emission is thermal vents, volcanoes and plants’ animals’ respiration. These are stable and have been around for billions of years. Whenever the CO2 level raises, plants, bacteria and algae thrived to reabsorb the gas from the atmosphere; thus stabilizing the CO2 content in the air. After billion years of absorbing and fixing carbon from CO2, a tremendously large amount of carbon is buried underground in the form of natural gas, coal or oil. These are greatly important energy sources for human. Without coal, the industrial revolution wouldn’t be able to occur. Without oil, the However, our development was so rapid that the environment isn’t able to keep up. With the population and quality of life constantly improving, we are consuming energy as a growing rate. Currently, the volcanic activities of the planet only accounts for 130 to 230 megatons of CO2 released into the atmosphere per year; this amount is less than 1% of the CO2 from human activities. Coupled with the deforestation that is going on all over the world now, the Earth is not able to absorb CO2 from our activities. Currently, only 57% of the CO2 from our activities is removed from the atmosphere by the biosphere and the ocean, the rest accumulates thus creating greenhouse effect. For the 21st century, Intergovernmental Panel on Climate Change states that the Earth’s temperature is likely to rise from 1.1 to 6.4°C. If the temperature increases just 4°C, many part of the world will be inhabitable by human, and many of the world’s natural systems will not be able to adapt, thus the benefits from the ecosystems would not be preserved.

There are complications with CO2. The gas, even if the emission stops, will continue to exist in the atmosphere for thousands of years more due to the ocean being the largest “carbon sink”. The ocean buffers the concentration of CO2 in the atmosphere by dissolving and releasing CO2 when there is any change. However, the ocean is not reliable in the future. When the CO2 content is high in the atmosphere, it warms up the Earth, thus making CO2 less soluble in the ocean. That is to say that the ocean will not be able to absorb as much CO2 as it does right now; in the worst case scenario, when the Earth is hot enough, the ocean will instead release CO2 into the atmosphere, making the Earth even hotter and the CO2 is even released faster, an example of positive feedback. So, to avoid that from happening, we have to cut down CO2 emission. Vehicles contribute to 25% of the total CO2 emission of the world; if we want to reduce CO2 emission, making “green” cars is a must.

**Economic and political instability:**

Aside from being a thread to the environment, the dependence on fossil fuel, specifically oil, creates concern over the stability of the economy of the United States. Oil has great impact on our economy. The US spends about $1 billion a day on foreign oil. Rising oil import pushes the US further into deficit, according to a report in 2009 from Center for American Progress.

From 2004 to 2008, the oil price spike cost us $1.9 trillion. Each time oil price goes up drastically like that, a recession happens. Furthermore, many of the countries from where we
import oil are considered “dangerous or unstable” on the State Department’s Travel Warning List. These countries have their “long-term, protracted conditions” that can cause complications to the US security and economy. Consuming more oil gives more political power to the oil exporting countries. That could threaten the stability of the world. Many oil exporting countries are volatile and unfriendly with the West, for example, Venezuela and Iran. They often use oil as a political mean to affect other countries decisions. The Organization of Petroleum Exporting Countries (OPEC), which controls two thirds of the oil reserves in the world, was also formed as to increase their economic and political significance in the world. This organization manipulates the oil prices, a practice that is also known as cartel, to increase profit. The $1.9 billion loss from 2004 to 2008 was partly caused by this organization.

So why do we still use oil? Most of the oil is consumed by vehicles, 71% of the petroleum in the US is used for transportation, 23% is for industrial usage, the rest is for residential and electricity. So, mostly we use it to run our cars. The reason petroleum products are used exclusively for cars is that they can be extracted quite easily compared to other types of fuels; they also have really good energy density, which gives a very good travel range. So, to end the dependence on oil, we have to think of an alternative way to power our vehicles.

II. Proposed solutions:

Hydrogen fuel cell:

(NW) One often proposed alternative fuel for vehicles is hydrogen fuel to be used in hydrogen fuel cell vehicles. However, hydrogen fuel is not an ideal alternative to petroleum products for a variety of reasons which will be outlined in this paper. However before we get into the reasons why hydrogen is not an ideal fuel, how hydrogen can be used to produce energy and its properties must be examined.

Hydrogen is the lightest and most abundant chemical element, making up over 75% of the normal matter in our universe. It normally consists of a proton and an electron however two other isotopes of hydrogen exist, deuterium which contains an additional neutron, and tritium which contains two additional neutrons. However while hydrogen is abundant in the universe, it is not normally found on Earth for two basic reasons. Hydrogen is extremely light and as such any hydrogen released into the air would eventually float to the exosphere layer of the atmosphere due to buoyancy and would be lost to outer space. The other reason is that any hydrogen found inside of the atmosphere would quickly undergo combustion with oxygen and form water, therefore hydrogen cannot normally be found on Earth. In order to produce hydrogen, steam reforming of fossil fuels or electrolysis of water is normally conducted to obtain hydrogen.

There are two ways of obtaining energy from hydrogen. One could combust hydrogen with oxygen found in air to produce heat that drives a piston in an internal combustion engine much like how gasoline powered vehicles work. However heat engines are notoriously inefficient, therefore fuel cells which extract electrical energy directly from chemical energy are preferred as they are more energy efficient. Fuel cells work by using a catalyst to ionize a hydrogen atom into a proton and an electron. The electron then passes through an electric circuit,
doing useful work, while the proton passes through an electrolyte to a cathode where it is united with the electron and oxygen to form water.

However there are several problems that exist with using hydrogen as a fuel and with fuel cells in general. The most important disadvantage is that unlike petroleum, coal, natural gas, or uranium, hydrogen is not an energy source. As stated before, hydrogen is not normally found in its natural state on our planet, therefore it has to be manufactured through some other means like electrolysis. This process involves using energy from another energy source to convert it into hydrogen, thus hydrogen is nothing more than an energy carrier for the original energy source. Steam reforming of fossil fuels is by far the most common method of producing hydrogen, however the act of reforming produces carbon emissions anyway so there are no benefits in terms of reducing greenhouse gasses, and there are energy losses in producing hydrogen from fossil fuels, so from an efficiency point of view, you are better off using the fossil fuels in a vehicle’s engine in the first place.

However one might argue that electrolysis of water to produce hydrogen as an energy carrier could be feasible if the energy source was clean as is the case with hydroelectric power or nuclear energy. However, the performance of hydrogen as an energy carrier must be evaluated to determine if its properties as an energy carrier are desirable. For vehicles, the amount of energy the fuel contains is an extremely important property to consider. There are two ways to measure the energy of a substance, energy density and specific energy. Energy density evaluates the amount of energy a substance has per unit of volume, while specific energy, determines the amount of energy the substance has per unit of mass. For vehicles, volume is more of a commodity than mass is typically, so while hydrogen has excellent specific energy with 123 MJ/kg, its energy density is terrible, with only 5.6 MJ/liter compared to gasoline’s energy density of 34 MJ/liter. For this reason, combined with the problems associated with infrastructure replacement, cost of the fuel cells themselves (which are far more expensive than internal combustion engines), and the efficiency problems associated with producing hydrogen in the first place, hydrogen is simply not a good fuel to use in vehicles.

**Natural gas:**

Another alternative to gasoline is natural gas. Natural gas is a mix of various hydrocarbon gasses that primarily consists of methane. Natural gas has the advantage in that it produces less carbon dioxide emissions per joule than any other fossil fuel including coal. Natural gas also produces less sulfur dioxide and nitrous oxides than any other fossil fuel. Unlike hydrogen, natural gas also has the advantage of being an energy source that is widely available even in the United States. As an energy source, that means that the energy is coming directly from the natural gas, or specifically methane. This reduces costs and improves efficiency as the substance doesn’t have to go through a process that turns it into another form. Such processes, such as the formation of hydrogen, have inefficiencies involved with them, and also raise the overall price of the final product. However a few things keep natural gas as a good alternative to gasoline. Namely the poor energy density of natural gas limits its utility in vehicles. As a gas, the energy per unit of volume is naturally low; because of this the gas must be compressed inside of a fuel tank in a car in order to have a reasonable travel range. Even then however, the compressed gas has very poor energy density. In fact it has only 0.0378 MJ/liter compressed at
1.013 bar, compared to 34 MJ/liter for gasoline and 38.6 MJ/liter for diesel. The fuel tank can of course be expanded to accommodate more methane, but this will cut into passenger and storage space as a result.

That is not to say that natural gas is not useful in vehicles, it can be. In larger vehicles like busses, a larger fuel tank can be accommodated to allow for more natural gas to be pumped in. Also in areas where natural gas is naturally abundant, having natural gas cars makes sense to have as the natural gas will be very cheap, and widely available. However, while methane has poor energy density, its specific energy or energy per unit of mass is very good. Methane has a specific energy of 55.6 MJ/kg while gasoline has a specific energy of 47.2 MJ/kg. Because of this, natural gas is probably best used to produce electricity where energy density problems are not a major issue, and specific energy is more important. As natural gas is the cleanest burning fossil fuel, it is an attractive alternative to coal.

Electricity:

(VN) The most desirable way to power a car is perhaps to use electricity. Why is it so? It’s because electricity is the most universal form of energy we have. Most of the energy we consume is, in fact, in the form of electricity.

Electricity can be generated from many sources like wind, solar, nuclear, coal, oil, etc. An electric car can actually utilize the energy harvested from sources like wind or geothermal, which a petroleum-driven car cannot. This feature gives electric cars the potential to be carbon-neutral. If in the future we decide to use renewable energies instead of fossil fuels to generate electricity, an electric car will be much more environment-friendly.

One would argue that since most of the electricity we generate today is from fossil fuels (70% of the electricity in the US is from coal and natural gas). Using an electric car would still emit the same amount of CO2 into the atmosphere. That argument is not quite valid. A car powered by electricity is much more efficient compared to a conventional car. An internal combustion engine is only about 30% efficient, that is to say only about 30% of the energy from its fuel is converted into useful energy; the other 70% is wasted in the form of heat. An electric engine normally can exceed 90% efficiency. The energy wasted is mainly because of friction. So, given the efficiency of thermal power plants are about 40% an electric car at 90% efficiency would have a total of 36% efficiency in converting chemical energy from fossil fuels to kinetic energy. That is less than the conventional 30%. And, with the efficiency of those thermal plants improved, which is happening with the arrival of the combined cycle technology, the total efficiency will be improved even further.

Then why aren’t electric cars popular? Electric cars have been pursued since the late 19th century and early 20th century, but it still has one crucial challenge. The problem is in the battery. The energy density of a battery is much lower than that of gasoline or other petroleum products so electric cars cannot travel as far as conventional cars. Because of that disadvantage, electric cars were outcompeted by gasoline cars since they were introduced. But with the current oil price, the difference in price between electricity and gasoline becomes large enough to divert some attention back to electric cars. The Nissan Leaf, the new model of electric car from Nissan,
costs about 3.5 cents to travel each mile. A conventional car at 30 mpg cost about 12 cents per mile. However, travel range is still an aching problem for electric cars. The Nissan Leaf can only travel 47-105 miles per full charge depending on the condition. Given the daily travel need of each person at about 40 miles, an electric car with 100 mile travel range should be enough to satisfy the drivers. When the driver needs to drive more than 100 miles straight, range becomes an issue. To make the matter worse, charging the battery take hours to complete. A 200 mile-trip that normally can be made in a few hours can in fact take days to complete. The driver always has to calculate how much they will have to drive before they start the car, which is much inconvenient.

There are several ways to solve the battery problem. One is to install charging stations everywhere so that whenever the car is not used, it is charged. That will help reduce somewhat the amount of time people will have to spend charging their cars at home, but will not solve the range problem. A solution for that was proposed: battery swapping stations. If the ownership of the battery is separated from the ownership of the car, we can introduce battery swapping stations. A car with a depleted battery can just get in the station and get its battery swapped for a fully charged one; that would effectively “refuel” the car. Even though it is effective, this method would require a lot of investment in infrastructures.

In conclusion, electric will perhaps be the best choice for the future, but with the current battery technology, that future is long to come.

**Ethanol:**

In the US, ethanol has been produced by using starch from corn. Ethanol can be used to mix with gasoline for vehicle usage or to run vehicle without mixing at all. Current, gasoline mixed with ethanol (E10, E85, etc.) has been made available in the US and several other countries in the world. Especially E10 fuel, which contain 90% gasoline and 10% ethanol, is widely available due to its compatibility with current vehicles. Mixtures of gasoline and ethanol with 10% ethanol or less can be used safely in existing gas vehicles. The aim of this method is to reduce the dependence the economy on oil and at the same time reduce green house emission. However, there are some disadvantages of using ethanol for fuel. Ethanol has lower energy density than gasoline (24 versus 34.2 MJ/L) so a car on ethanol would need a larger fuel tank to cover the same distance as a gasoline car. That might not be much of a problem; the problem is whether the process is energy efficient. According to some analysts, producing ethanol to replace gasoline actually creates more greenhouse gases than using gasoline itself because of the fuel consumed in the process.

According to the Wall St. Journal, June 17, 2006, “The most widely cited research on this subject comes from Cornell's David Pimental and Berkeley's Ted Patzek. They've found that it takes more than a gallon of fossil fuel to make one gallon of ethanol — 29% more. That's because it takes enormous amounts of fossil-fuel energy to grow corn (using fertilizer and irrigation), to transport the crops and then to turn that corn into ethanol.” That is, clearly, not efficient. If all the corn in the US were used to made ethanol it would only replace 12% of the gasoline consumed in the US. There’s a limit to how much crop we can grow,
ethanol-producing crops would then compete with agricultural crops on water and land, making the food price rise which will have a devastating effect on the economy.

There is an alternative for producing ethanol. We can in fact harvest create ethanol from cellulose, which contains long chains of sugars, the material needed to ferment into ethanol. Cellulose is abundant in plants, most of the plant materials are cellulose; starch is only a small portion of that. So, if we can use the energy stored in cellulose, we can utilize a lot of the waste from our crops that are currently just made into fertilizer or thrown away. There have been projects about producing ethanol from plants but with the current method, the cost of producing ethanol from this method is not lower than the cost of using starch. This is due to the fact that breaking down cellulose involves multiple steps, and the efficiency of each step is not very high. At the end, the amount of ethanol produced is not great. Hopefully, with research, the cost of cellulosic ethanol in the future will be lower and that will help ethanol play a much larger role in the global energy schemes.

All of the biofuels have one great advantage is that they can be potentially carbon-neutral, that is to say they don’t release more carbon to the atmosphere. The explanation is that in order to produce ethanol, carbon from the air must be collected into plants, and the carbon is then re-release into the air; it’s a close loop. But to be able to do that, the production of these fuels must not involve fossil fuels. To improve the situation, we have to replace these fuels with other forms of renewable energies.

**Algae Biofuel:**

(NW) In order to be a suitable substitute over petroleum based products like gasoline, and diesel, fuels powering vehicles must have very good energy density. While ethanol is a common biofuel, its limitation is in its energy density which is only 18.4-21.2 MJ/L compared to 32-34.8 MJ/L for gasoline. This means total travel range of a car running on a full tank of ethanol is about 1.64 times less than the same car running on a full tank of gasoline. However biodiesel has excellent energy properties with its energy density being 33.3-35.7 MJ/L. This makes it an ideal energy carrier for solar energy, which is the energy source for all biofuels.

Algae can be used to produce various biofuels such as biodiesel and biogasoline. Biofuel produced from algae has many desirable traits over other biofuels produced from terrestrial crops. One major problem with terrestrial crops is that they require enormous fields to grow. Since land is a limited commodity, total energy produced from terrestrial crops is also limited. Theoretical fermentation yields on biomass and the specific energy of ethanol project a max yield of 96 billion gallons of gasoline equivalent fuel. The US consumed 140 billion of gasoline, 40 billion gallons of road diesel, and 20 billion gallons of jet fuel per year. As one can see, reliance on terrestrial crops alone is not sufficient to replace petroleum consumption entirely in America. However Algae does not need to be produced on land, it can be produced on water, including sea water and can produce more energy per unit of area than any terrestrial crop. The United States Department of Energy estimates that if algae fuel replaced all petroleum fuel in the US, it would require only 15,000 square miles. This is only 1/7 the area of corn fields harvested in the US in 2000.
Algae can be divided into two groups, macroalgae and microalgae. A common example of macroalgae would be seaweed, however given the issues of harvesting costs, and issues with fuel conversion, they are not ideal for producing biofuel. Microalgae are considered more amenable to production of biofuels. Microalgae themselves can further be divided into eukaryote (having well defined cell nucleus) and prokaryote (no well defined cell nucleus) types. Due to the simpler structure, prokaryote algae are easier to genetically engineer, but do not produce as much oil as eukaryote types. Eukaryote types are abundant in neutral lipids which are rich in triacylglycerols or TAGS. These TAGS are made up three fatty acid molecules that can be converted to glycerol, so almost all of the TAGS’ weight is converted into fuel. Polar lipids only possess one or two fatty acid molecules which are converted into glycerol. The rest is composed of sugar or phosphate groups which cannot be turned into biodiesel, however the sugars can be fermented into ethanol in a later process.

While microalgae already produces copious amounts of oil, the oil yield can potentially be further improved with genetic engineering. Only about 30%-50% of polar lipids can be directly converted into fuel while 100% of neutral lipids can be directly converted into fuel. When algae cells are subjected to deprivation of essential nutrients, growth is reduced in favor for storage of energy which is accomplished by the production of carbohydrates and TAGS. TAGS are essential to the production of biofuel, however little is currently known about how the cell regulates between the production of carbohydrates and TAGS. With more research, a better understanding of how this is accomplished could be discovered which can lead to genetically modified algae cells that produce more neutral lipids which are rich in TAGS.

Utilizing algae has significantly less hazards as harvesting and utilizing petroleum. Since the product is domestically grown, hazards involving the transportation of crude oil are eliminated. Leakages of algae into the environment are also not a major hazard, however there is some concern involving the use of genetically engineered algae. Improving the oil production of algae involves the use of genetic engineering. There is concern of what might happen if large scale production of genetically modified algae is set free into the wild and infiltrates other species. What would the effects be? Would the effects be negligible? Beneficial? Harmful? The answers to the questions are still unclear, and require further research.

Real development on algae biofuels began in 1978 with the Aquatic Species Program. The goal of the program was to assess the feasibility of using aquatic plants to produce fuels for vehicles. At first, research was focused on using microbes to produce hydrogen, but then in 1982 researched shifted on producing biofuel from algae. It was from this research that nutrient deprivation of algal cells increased production of TAGS, and over 3000 algal strains were identified and 51 were determined to be ideal for oil production. In total, $25 million was granted to the Aquatic Species Program over the course of 18 years, and then the program was halted in 1996. Due to a lack of funding, maintenance of the strains was cost prohibitive and over half of the highly valued algal strains were lost.

The American Recovery and Reinvestment Act of 2009 allocated $800 million in total to biofuels in general. The vast majority of the funds were used for pilot and demonstration-scale integrated biorefineries. The projects granted funds are to demonstrate the production of cellulosic ethanol, renewable diesel, and jet fuel. These grants are intended to improve the
volume of biofuel produced from 1 billion gallons per year in 2010, to 21 billion gallons per year in 2022. $82 million was set aside for an existing biorefinery project, and $107 million was allotted for fundamental research in certain key areas. These programs are to demonstrate the improved conversation technologies in producing better catalysts and fuel-producing microbes. However one of the most important developments in biofuels, the improvement of TAG production in algal cells, was allocated only $49 million. Understanding TAG development and engineering TAG production is key to improving the yield of oil per algae cell and remains one of the most important areas for improving biofuels. It is estimated that 2,600 jobs will be created as a result of all of the funding allocated to biofuel research.

However most disappointing was the lack of any funds for algae biofuels in the Energy Independence and Security Act of 2007. Grants were provided to entities that were conducting research and development in ethanol but had low rates of production of cellulosic biomass ethanol. No similar provisions were made for algae biofuel, however a report was requested to assess the progress being made in research and development on algae biofuels.

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Service Project:

Using Algae for Carbon Capture

(NW) Algae can be used to reduce CO2 emissions by capturing the CO2 emitted from coal powered power plants by filtering the CO2 emitted to the algae where it is then absorbed via photosynthesis. In nature, algae absorb an enormous about of carbon. The amount of carbon algae absorbs is equal to the carbon emitted from 65,000, 500 MW power plants.

Normally carbon captured from fossil fuel powered power plants is filtered underground and securely storing it away from the atmosphere. However as the process of compressing and pumping the CO2 requires energy, it is estimated that a coal power plant needs 25%-40% more
fuel in order to accomplish this process. Additionally, improperly stored CO2 could leak out into the atmosphere, defeating the entire process. By channeling the CO2 to algae ponds for the purposes of producing biofuel, two goals are being accomplished. We are transforming a waste product into a resource, and we are eliminating the CO2 from the environment entirely so leakage from storage is non-existent.

**Letters to energy companies:**

(VN) Our project is to propose the idea to energy companies that currently have the most coal power plants in the US. The companies include American Electric Power, Southern Company, Duke Energy, Tennessee Valley Authority, Dominion, FirstEnergy. This is the format of the letters I sent.

Greetings,

I write this letter to you to address an environmental issue and propose a solution to it. Coal power plants have been the leading source of CO2 emissions, which is responsible for global warming. However, electricity is absolutely necessary in our society, thus if there is a way to generate it economically, that way is appreciated. As a person who cares about our future, I want to propose a solution that will take care of the greenhouse gas emission from the plants: use algae to absorb the CO2.

Algae can be used to reduce CO2 emissions by capturing the CO2 emitted from coal powered power plants by filtering the CO2 emitted to the algae where it is then absorbed via photosynthesis. In nature, algae absorb an enormous about of carbon. The amount of carbon algae absorbs is equal to the carbon emitted from 65,000, 500 MW power plants.

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If this is effective, which I do think it is, it will help keep our environment clean for the future and also maintain the company’s reputation.

Thank you for your time,

Vu Ngo
Letters to the Editor:

This letter was submitted to The Daily Targum

Nuwan Weerahandi
Class year: 2012
School of Environmental and Biological Sciences

A Case for Hydrogen Fuel Cells?

Why have politicians such as George W. Bush attempted to inculcate the general populace into believing that hydrogen fuel cells were ever a viable alternative to gasoline? Do they work? Well yes. But were they ever viable? No. Did they offer any advantages over other alternative fuels? No. Were they cheaper? No. Was there ever a point? No. So then why was there a push for Hydrogen vehicles, and even working models of them? Anyone who had the expertise to even make a hydrogen fuel cell vehicle would have the knowledge to easily assess that they can never be used as a way of powering vehicles.

I suppose part of the problem is that the vast majority of people out there don’t even know what a hydrogen fuel cell is, let alone understand how it works. Feeding off of ignorance can drum up support for any stupid idea. In short, hydrogen fuel cell vehicles are not feasible because hydrogen has poor energy density and hydrogen is not an energy source. That’s actually bad enough to make it infeasible alone, but then there’s the extreme expense of a hydrogen fuel cell, the freezing of water in its fuel cells during the winter, the fact that it requires a complete overhaul of our fueling infrastructure, and the questionable service life.

It seems pretty obvious that the push for hydrogen fuel cells was perpetuated by those who had invested interests in continuing our dependence on petroleum. They knew that hydrogen fuel cells for vehicles were a technology that would go nowhere, and they would claim support for it because it would deviate resources from true alternatives that could actually compete with petroleum. So this entire act is nothing more than deception to indirectly help oil companies. So what’s the solution? Educate the masses on this for starters. People can’t afford to be so ignorant of these technologies because then they will be deceived by those who stand to lose money if we ever emancipate ourselves from our dependence on foreign oil.

-Nuwan Weerahandi

This letter was submitted to The Boston Globe.

Dear Editor,
Global warming is an issue and it has to be stopped. To fight global warming, we have to cut down the CO2 emissions. The leading source of greenhouse gas emissions are coal-fired power plants. So, I want to propose a method to absorb the CO2 emitted from these plants: use algae. Algae can be used to reduce CO2 emissions by capturing the CO2 emitted from coal powered power plants by filtering the CO2 emitted to the algae where it is then absorbed via photosynthesis.

Normally carbon captured from fossil fuel powered power plants is filtered underground and securely storing it away from the atmosphere. However as the process of compressing and pumping the CO2 requires energy, it is estimated that a coal power plant needs 25%-40% more fuel in order to accomplish this process. By channeling the CO2 to algae ponds for the purposes of producing biofuel, two goals are being accomplished. We are transforming a waste product into a resource, and we are eliminating the CO2 from the environment.

Thank you,
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