



## The controversy of biofuel versus fossil fuel

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### ABSTRACT

Over the past few decades, as fossil fuel usage continues to increase, researchers and government laboratories have been continuously investigating on converting biomass to fuel, but with little fund given. Now, as the comparative fuel price changes, the biofuel seems to be appealing to different sectors. Swarms of consultant, media and investors are buzzing around alternative fuel technology, but many questions on the controversial issues still remain puzzling. This paper explores on the comprehensive differences and impact between biofuel and fossil fuel from the environmental, economy and energy aspects.

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### 1. Introduction

Many studies have been conducted in terms of quantitative effects and assessed the reductions of greenhouse effect from substituting fossil fuel to biofuel. Fossil fuel nowadays addressed as conventional fuel includes coal, petroleum/oil, and natural gas are a natural source from the earth. They are produced from the decomposition of animals and plants that lived millions of years ago and remain buried for a few million years under anaerobic situations. This was first discovered during the 13th century by British populations that found black rocks along the shore known as 'sea coles' would burn. Following this discovery, there are many coal mining activities all over because of its importance for metal or iron industries, the locomotive, development of steam engine, the steam electric power and the steam ship.

The development furthers when after a century when the second largest source of fossil fuel, petroleum and natural gas were found, which leads to the creation of internal combustion engine, aero plane, diesel-electric power and automobile (Hubbert, 1956). Fossil fuels continued to be the main source of the world energy and later become the main source or carbon dioxide (CO<sub>2</sub>) emissions. Statistics shows that these fossil fuel resources have been depleted rapidly because of constant use. More than 80% of world's energy consumption comes from fossil fuel, shown in Fig. 1 (AER-EIA, 2009). This energy sources are not renewable and once it is been used up, it will be gone permanently.

### 2. Renewable fuels

Biofuel on the other hand are renewable fuels which been derived from biomass includes primary resources such as wood. There are also secondary sources like ethanol, methanol, and biogas which originate from bioconversion of primary produced photosynthate (Lewis, 1983). The first form of biofuel used is almost as old as the diesel engine invented by Rudolf Diesel. He patented the engine in 1892 and introduced the first diesel engine to run on vegetable oil. The initial biofuel to run the engine was in the form of groundnut oil and was successfully tested for several hours. Originally the engine was designed to be used in a dual fuel nature (McDonnell et al., 1999). These two types of fuel engines remained in use for a long time until 1940, when a large amount of petroleum were found, moreover the process of producing it were a lot easier and cheaper. This lead the engineers to concentrate more on diesel engines and dual fuel engines died off. Since then, they have been less interest in using vegetable oil in diesel engines for many reasons including economic aspects and political considerations.

### 3. Biofuel and Fossil Fuel Controversy

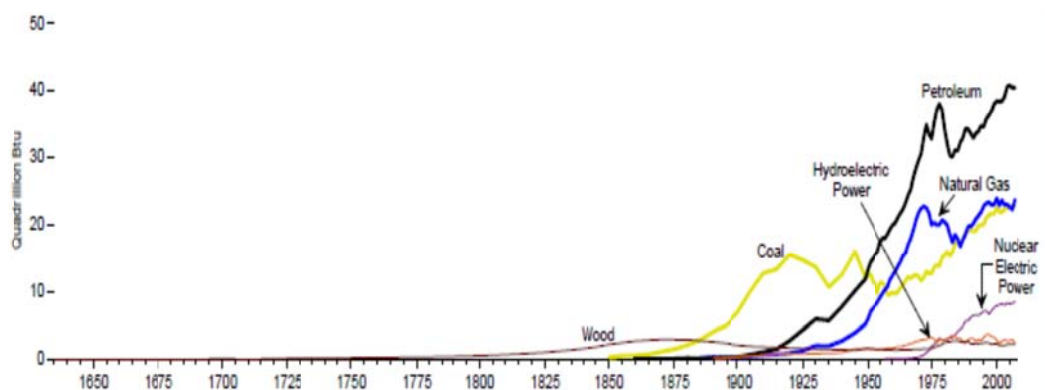
Over the past ten years, the interest in biofuel has followed the up and downs of the world oil prices. As oil prices shoots up, actions are taken in search of alternative fuels such as biofuel. One of the best forms of biofuel can be biodiesel. It is made from various types of oil seed crops such as palm, sunflower, olive, cottonseed, eucalyptus, rapeseed, soya bean, groundnut and other vegetables. Mostly the type of biofuel discussed falls under the category of agrochemical fuel extraction to describe production of biodiesel from plants where the plants

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usually remain alive and unharmed. Sometimes it is also possible for the whole plant to be harvested for fuel extraction. The products are usually oils and solvents which require minimum effort of secondary processing (Twidell and Weir, 2015). Other forms of

biofuel can be in the form of ethanol produced from carbohydrate fermentations or methanol from gasification processes which can be derived by biomass sources (Lewis, 1981).



**Fig. 1:** Annual energy consumption from 1635 to 2008, Source from AER-EIA (2009)

Discussions and reviews in this context are mainly focused on environmental and health issue. Today we can see energy for industrial purposes, transportations, commercial and home use, as well as electrical generation mainly supplied from conventional fuel (fossil fuel). The main impact of this is carbon dioxide (CO<sub>2</sub>) emission leading to the major cause of greenhouse gas (GHG) effect. Kyoto Protocol therefore has been endorsed and enforced in many countries setting the maximum emission of the six GHGs for them (Reilly et al., 1999). Biofuel have been proved to reduce the GHG emissions like hydrocarbon (HC), carbon monoxide (CO), sulphur dioxide (SO<sub>2</sub>) and particulate matter (PM). Biofuel have been proven to reduce the acid rain impact from SO<sub>2</sub> (Shahid and Jamal, 2008). Studies have been performed on biodiesel and the oxides of nitrogen (NO<sub>x</sub>) measured are approximately 9% more than those measured from the combustion of fossil fuel (petroleum/diesel). The only gas reported to be increasing during the biofuel combustion is NO<sub>x</sub> (Sharma et al., 2008). Several changes can be made during the biofuel processing and production to reduce NO<sub>x</sub>, such as better ethanol manufacturing method, change composition of raw material (feedstock), adding acetone to the process, improvement in process timing and proper waste management (Schubert, 2006)

More biofuel need to be used compared to fossil fuel (diesel) to travel a similar distance. Both type of fuels reported to have the same CO<sub>2</sub> emissions per mile travelled. The process of growing plants absorbs carbon dioxide therefore balanced the CO<sub>2</sub> emission to the atmosphere when used as biofuel (Gaffney and Marley, 2009). Studies performed in Sweden by substituting fossil fuel to biofuel using biomass has seen positive results in reduction of CO<sub>2</sub> emissions. This substitution has been made in comparison with the fossil fuel by per unit of used land or biomass (Gustavsson and Svenningsson, 1996). However Gaffney and Marley (2009) reported

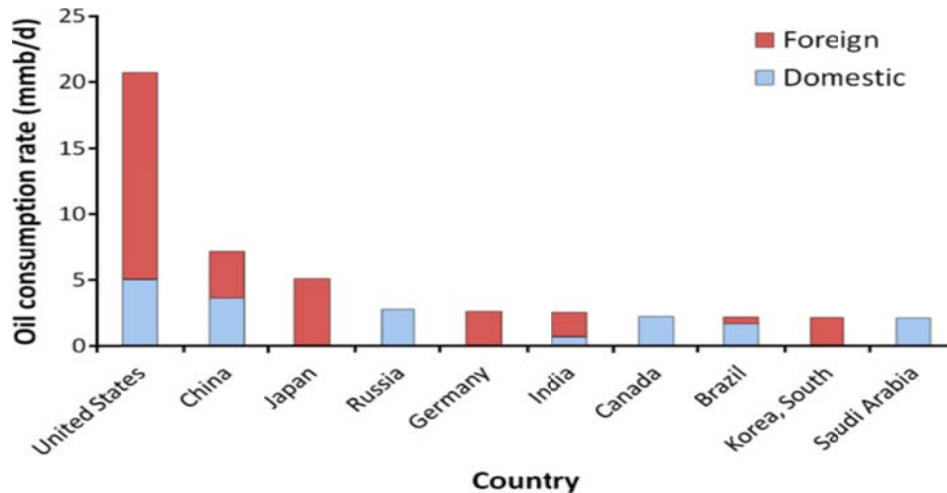
that the CO<sub>2</sub> that have been considered for the entire life cycle of yielding the biofuel are not possible to result in decreasing amount of CO<sub>2</sub> emissions. At this point there are some controversies on this issue as some authors argue that that the energy balance reduces CO<sub>2</sub> while others says it is negative or at best a similar impact as fossil fuel.

Suggestions have been made that planting more trees on a very large scale will fix the CO<sub>2</sub> in the atmosphere. This idea has attracted much attention, but the process of clearing rainforest and replanting of large areas would raise the doubt that it is beneficial to the atmosphere. Farrell et al. (2006) mentioned that life cycle analyses did not consider many of the environmental impacts of biofuel due to plantation which causes large amount of water consumption and soil erosion. Fertilizers and pesticides usage will also contribute to the environmental pollutions (Powlson et al., 2005). Another controversial issue is food versus fuel. The conversion from fossil fuel to biofuel will need excessive amount of land use, changing feedstock to biofuel. Risks are the increasing of food prices that will then lead to malnutrition and famine. The energy balance needs to be considered as well. The amount of biofuel needed from crops to fill a sports car tank could easily feed a person for 365 days (Koh and Ghazoul, 2008). When all energy inputs (planting crops, fertilizing, harvesting, productions and processing, transportations, etc.) are all taken into considerations, the fossil fuel energy input are actually greater than the biofuel output (Boyle, 2004).

Biofuel usually concerns of processing vegetable oil with methanol or ethanol, which is non-toxic and biodegradable. Biofuel (biodiesel) degrades four times faster than fossil fuel (petroleum) which is a positive value to the environment (Tyson and McCormick, 2001). Neat biodiesel reported to reduce number of cancer cases compared to fossil fuel combustion which is 10% higher than biofuel.

Referring to health and handling concerns, biofuel is less harmful to the eye and skin in case of any direct

contact (Zappi et al., 2003) (Fig. 2).



**Fig. 2:** Ten largest oil (fossil fuel) consumers' consumption rate with breakdown of the domestic production and imported amount expressed in million barrels per day (mmb/d) in 2006. Source from EIA-DOE (2008)

#### 4. The controversy discussions

Rising of fossil fuel costs makes the need to substitute from fossil fuel to biofuel more important especially to reduce imports from other countries. Ten world highest oil consumers are not producing the amount of fuel they needed therefore have to import the remaining need (Fig. 2; EIA-DOE, 2008). Consideration should be taken on the concept of replacing fossil fuel with biofuel to reduce the GHG emission and stabilize climate change as this might not be possible but will also have bad impact on the ecosystem, land and water supply (Jacobson, 2004). Perhaps replacing fossil fuel with biofuel serve the purpose of reducing the fossil fuel dependence, but other issue such as GHG emissions, increasing food prices, forest clearance for plantations which impact the ecosystem, competition for water, fertilizer and pesticides side effects still remains and some even increased. Other effects of biofuel are positive towards environment which is high rate of degradation, and less harmful for human handling or direct contact with this type of fuel. There are still other issues that need to be look into further and not discussed which is the economic point of view. The cost of producing biofuel relative to fossil fuel, the production planning and storage concerns, impact to rural area incomes and proper production techniques or methods need to be studied thoroughly to get the best out of it. It is important to really assess the importance on non-economic benefit as well whether it is huge enough to compensate for its disadvantages such as land usage, fertilizers pesticides, water consumption for non-food purpose, and the price to consumers and taxpayers. The real comparison would be more practical if it is between biofuel and other bioenergy such as hydrogen, wind, solar, geothermal or hydro power. New developing and available technologies would be able to reduce the world's dependence on

fossil fuel and to insure a sustainable energy source in the future.

#### 5. Conclusion

In the real world nothing is ever perfect. This implies to the energy source as well. None of the energy source or fuel source today is ideal. Changing our way of using these sources perhaps would be a better solution rather than keeps looking for the best replacement to fossil fuel or biofuel. Conserving the energy we have would greatly benefit for all of us. For example, human beings should use only what we really have to. Carpooling, using public transport whenever possible, cycling or walking to a reasonable distance, switching off electrical appliances when not in use, and practice of recycling would definitely reduce GHG emissions. Governments play important roles in encouraging all to be aware and consistent, not only when the fossil fuel price increases. Encouragement should start by reducing vehicle tax to users travelling less mileage, provide tax incentives to organization that uses green energy source and recycle waste so that consumer do not have to pay more when using goods or product made from recycled materials. Combination of energy conservation as well as carefully selecting and understanding the best alternative fuel which has the most cost effective and is most beneficial to the environment will balance out the dilemmas and problems faced in choosing between fossil fuel and biofuel.

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