

THE IMPACT OF ALTERNATIVE ENERGY TO HUMAN SUSTAINABILITY: A REVIEW

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ABSTRACT

The climate change and the depletion of fossil fuel is one of the world scale issue which will affect the human being. So, an innovative way must be addressed to solve these issues including environmentally friendly technologies to reduce air pollution, greenhouse effect, global warming, and climate change. In order of that, this paper present the innovative and sustainable way to mitigate these issues which are by using the alternative energy to substitute the fossil fuel usage. The objectives of this paper are: a) Define the sustainability and how the greenhouse gases and fossil fuel depletion affect human being b) Address an innovative way to mitigate the issue c) Address the impact of alternative energy to environment, energy security, and economic. The alternatives energy discussed are included the utilization of CO₂ into fuel, and the implementation of biomass technology to produce biofuel. This is because these methods promoted positive impact when the CO₂ utilization can decrease its concentration in atmosphere and biofuel can enhance the socioeconomic. Moreover, both method can increase world energy security.

Keywords: Sustainability; climate change; fossil fuel depletion; alternative energy.

INTRODUCTION

Human sustainability involves specific goals, strategies and methods implemented to preserve and improve the quality of human life. Sociological, environmental and resource-based factors contribute to human sustainability. Sustainability grows out of a need for intertemporal ethical rules when one generation can determine the endowment of natural and constructed capital that will be passed on to all subsequent generations (Bromley, 2008).

Population growth is a major concern in human sustainability. As populations grow, the amount of space and natural resources available to supply them wanes in comparison. Pushes for environmental resource preservation and responsible usage of resources are also important to meeting needs of growing populations (Kokemuller, 2014).

The organizing principle for sustainability is sustainable development, which includes the five interconnected domains: ecology, economics, social, politics and culture (Awadallah, Fini, & Mellat-parast, 2013)(Ayhan Demirbas, 2009)(Balat, 2007). The concept of sustainability relates to the maintenance and enhancement of these domains in order to meet the needs of current and future generations.

Ways of reducing negative human impact are environmentally-friendly technology and development, environmental resources management and environmental protection (Lorek & Fuchs, 2013). Therefore, renewable resource inputs must be kept within the regenerative capacities of the natural system that generates them. Additionally, the extraction of non-renewable resources should be minimized and not exceed the minimum strategic levels (Rahman et al., 2017).

In order of that, this paper is discussed about the important of alternative energy to human sustainability. The objectives of this paper are: a) Define the sustainability and how the greenhouse gases and fossil fuel depletion affect human being b) Address an innovative way to mitigate the issue c) Address the impact of alternative energy to environment, energy security, and economic.

Problem Statement

According to recent IPCC reports, the global mean concentration of carbon dioxide (CO₂) in the atmosphere is now close to 400 parts per million (ppm); however, the most comprehensive research states that the safe level of CO₂ concentration is below 350 ppm (Wennersten, Sun, & Li, 2015). It should be mentioned that the atmospheric CO₂ has important and positive roles in the ecological system, since photosynthesis and food production depends on it as a carbon source. The percentage of CO₂ in greenhouse gases (GHGs) emissions is about 77% which will significantly cause climate change (Rahman et al., 2017)(C2ES, 2005). The CO₂ concentrations increased significantly and continuously rising at a faster rate due to rapid development (Song, 2006).

On the other hand, the resources of petroleum and natural gas that took tens of millions of years to form and accumulate have been consumed so fast in the last 80 years that they have shrunk to one to two human life spans (Song, 2006)(Weisz, 2004). A major challenge of fuel usage is that the fossil hydrocarbon resources are being consumed so rapidly worldwide. It has been estimated that petroleum-based resources will be depleted in less than 50 years at current rates of consumption (Höök & Tang, 2013)(Hirsch, Bezdek, &

Wendling, 2007)(Sheehan, Camobreco, Duffield, Graboski, & Shapouri, 1998).

This climate change and the concomitant depletion of fossil fuels lead to the utilization of alternative and renewable energy sources (Rahman et al., 2017)(Nasterlack, von Blottnitz, & Wynberg, 2014)(Escobar et al., 2009). Although CO₂ is a greenhouse gas that cause climate change and global warming, but it also an important source in conversion for making fuel, organic chemicals, materials and food (carbohydrate) by synthesis process (Song, 2006). In the other word CO₂ is significantly potential feedstock to produce other material. In developed countries, there is a growing trend towards employing modern technologies and the efficient conversion of various feedstocks into energy, as a result of which renewable energy have become competitive in terms of cost with fossil fuels (Rahman et al., 2017). The utilization of CO₂ and biofuel production will not only help mitigate global warming, but also provide an inexhaustible and generally-available carbon source for years to come.

ALTERNATIVE ENERGY SOURCE

The alternative energy which will be discussed in this paper only comprised fuel that utilized from CO₂ and biofuel production. Alternative energy can be form from renewable energy or conversion from another element such as CO₂. Renewable energy is energy that is collected from renewable resources, which are naturally replenished on a human timescale (Ellabban, Abu-Rub, & Blaabjerg, 2014) (REN21, 2010).

The other alternative is biofuel. Biofuel technology is relevant to both developing and industrialized countries. For this reason, the share of biofuels in the automotive fuel market is expected to grow rapidly over the next decade. Biofuels could be peaceful energy carriers for all countries. They are renewable and available throughout the world. As fossil fuels are a limited resource, finding alternative energy source has become a high priority worldwide (Kim, Kim, & Dale, 2009).

Utilization of CO₂ Into Fuel

The sustainable option discussed in this paper is the conversion of CO₂ from a damaging GHG that causes global warming into a valuable, renewable, and unlimited carbon source (Olah, Goepfert, & Prakash, 2009). The utilization of CO₂ for fuel will not only help mitigate global warming, but also provide an inexhaustible and generally-available carbon source for years to come (Rahman et al., 2017)(Pearson et al., 2012).

There are several fuel products that can be produced from CO₂ including methane (CH₄), methanol (CH₃OH) and dimethyl ether (CH₃OCH₃). The key factor in the large-scale of fuel production process is the availability of the raw materials CO₂ and H₂. Large amounts of CO₂ can be obtained from

sources such as fossil fuel-burning power plants and industrial facilities through the use of carbon capture and storage technology (Rahman et al., 2017). An example of a carbon conversion cycle method from source to methanol and other hydrocarbon products is provided in Figure 1. Based on this figure, there is a method to recycle the CO₂ from industrial to become methanol (fuel). Methanol can be use as fuel for energy combustion which will emit CO₂ as a main product along with water (H₂O). Usually the released CO₂ is emitted as a waste into atmosphere, however based on this method, it can be use again to produce methanol. In consequences, this method will not only can reduce the CO₂ concentration in atmosphere, it also can produce fuel from wasted emission.

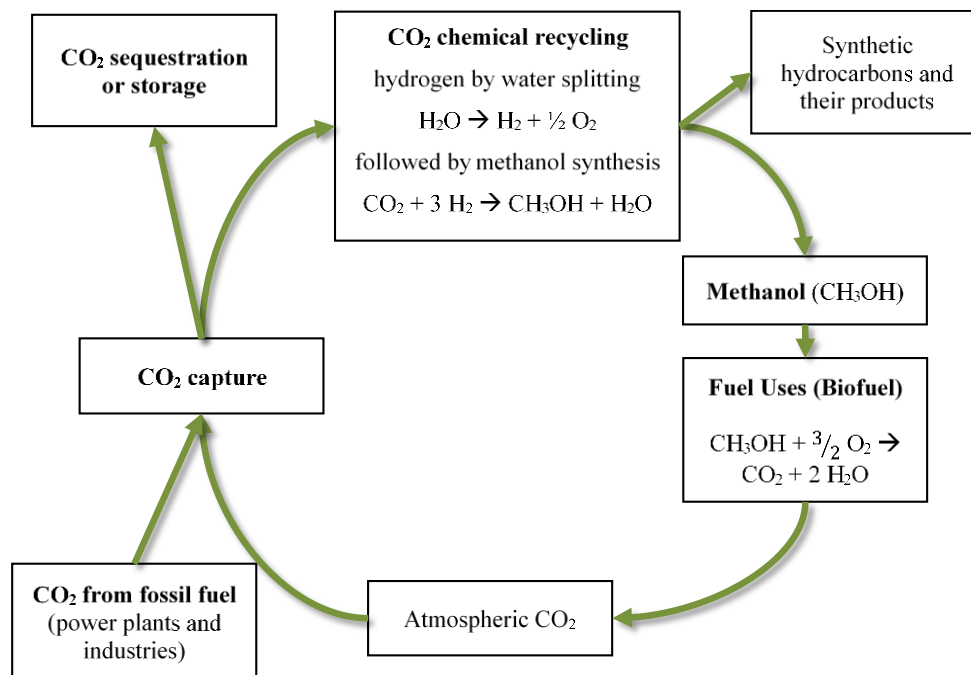


Figure 1 Carbon conversion cycle from source to methanol and other hydrocarbon products (Rahman et al., 2017)

Biofuel

The term biofuel is referred to as solid (bio-char), liquid (ethanol, vegetable oil and biodiesel) or gaseous (biogas, bio syngas and biohydrogen) fuels that are predominantly produced from biomass (Balat, 2008)(Ayhan Demirbas, 2009). Biofuel is a renewable energy source produced from natural (bio based) materials, which can be used as a substitute for petroleum fuels. The most common biofuels, such as ethanol from corn, wheat or sugar beet and biodiesel from oil seeds, are produced from classic food crops that require high-quality agricultural land for growth. However, ethanol is a petrol additive/substitute that can be produced from plentiful, domestic, cellulosic biomass resources such as herbaceous and woody plants, agricultural and forestry residues, and a large portion of municipal and industrial solid waste streams. There is also a growing interest in the use of vegetable oils for making biodiesel, which is less polluting than conventional petroleum diesel fuel (A. Demirbas, 2008).

However, the cost of biofuel is the main obstacle for its commercialization. Biofuels production costs can vary widely by feedstock, conversion process, scale of production and region. For biofuels, the cost of feedstock (crops) is a major component of overall costs. Total biofuel costs should also include a component representing the impact of biofuels production on related markets, such as food. In particular, the cost of producing oil-seed-derived biodiesel is dominated by the cost of the oil and by competition from high-value uses like cooking (A. Demirbas, 2008)(Ayhan Demirbas, 2009).

Method to Produce Biofuel

Bioethanol is one of the common biofuel. It can be produced from a large variety of carbohydrates with a general formula of $(CH_2O)_n$. However, it is also possible that wood, straw and even household wastes may be economically converted to bioethanol (Ayhan Demirbas, 2007). The process is as shown in Figure 2.

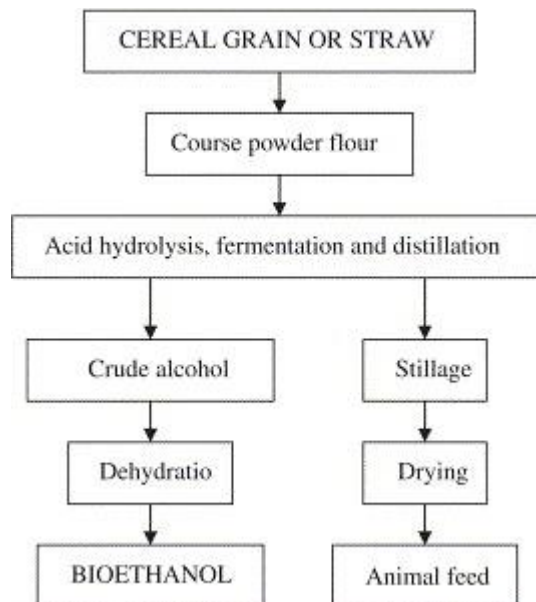


Figure 2 Bioethanol production from biomass feedstock (Ayhan Demirbas, 2007)

Fermentation is an anaerobic biological process in which sugars are converted to alcohol by the action of microorganisms, usually yeast. (Ayhan Demirbas, 2007). Fermentation of sucrose (which is found in plant) is performed using commercial yeast such as *saccharomyces ceveresia* (Du, Xu, Liu, & Zeng, 2004). The process is shown in Figure 3.

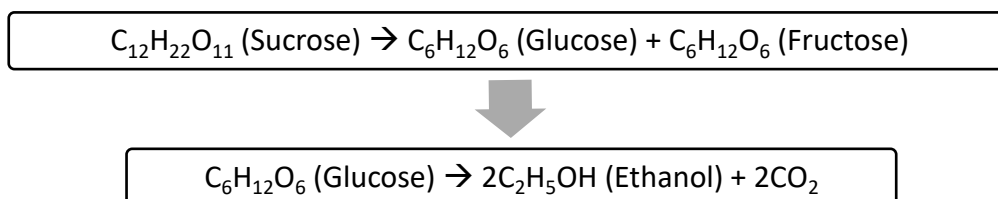


Figure 3 Fermentation of sucrose to ethanol

For the first step, invertase enzyme in the yeast catalyzes the hydrolysis of sucrose to convert it into glucose and fructose. In this process, hydrolysis breaks down the H₂ bonds in the hemicellulose and cellulose fractions into their sugar components: pentoses and hexoses. Second, zymase, another enzyme also present in the yeast, converts the glucose and the fructose into ethanol. The enzymatic hydrolysis is then followed by fermentation, distillation and dehydration to yield anhydrous bioethanol. Corn (which have 60–70% starch) is the dominant feedstock in starch-to-bioethanol industry worldwide.

SUBSTITUTION TO ALTERNATIVE FUEL

Fossil fuels can be renewed over geological time scales. However, it has been estimated that petroleum-based resources will be depleted in less than 50 years at current rates of consumption (Höök & Tang, 2013)(Sheehan et al., 1998)(Alekklett, Lardelli, & Qvennerstedt, 2012). The benefits of alternative fuel over traditional fuels include greater energy security, reduced environmental impact, foreign exchange savings, and socioeconomic issues related to the rural sector (Ayhan Demirbas, 2009). These are the reasons why CO₂ conversion and also biofuels production should be considered as an alternative energy source by both developing and industrialized countries (Rahman et al., 2017).

There are economic, social, and environmental impacts of biofuel production that must be addressed for its implementation (Cremonez et al., 2015). The major impacts are considered under three headings: those are largely a product of land-use change, particular feedstocks, or technology and scale (Phalan, 2009). These factors interact and the fraction is:

- i. Land-use related impacts (land tenure and labour rights, greenhouse gas balance, and biodiversity)
- ii. Feedstock-related impacts (food security, soil resources, water resources, human health, and invasive species)
- iii. Technology and scale (rebound effects and efficiency as well as energy security and scale)

Despite of positive impacts, there are several issues on the convenience of alternative energy to be implemented. This is a consequence of the potentially negative impacts revealed from their production on a large scale. The advantages and disadvantages of alternative energy are shown in Table 1. However, in some cases, for example in American Midwest, biofuel production is ideally suited to local conditions due to corn production, as the primary biomass input is available in large scale. In this context, for biofuel production in particular area, it is important to examine demographic characteristics, physical characteristics (variation in average rainfall, reliance on irrigated agriculture), plant ownership type (absentee vs. local), and community opposition in order to reduce the disadvantages to the local community (Kulcsar, Selfa, & Bain, 2015). Moreover, to ensure net societal benefits of alternative fuel production, governments, researchers, and companies will need to work together to develop comprehensive assessments, map suitable and

unsuitable areas, and define and apply standards relevant to the differing conditions of each country (Phalan, 2009).

Table 1 The advantages and disadvantages of alternative energy in social perspective

Types	Advantages	Disadvantages
Environment and ecosystem	<ul style="list-style-type: none"> -Reduce CO₂ from atmosphere (Ayhan Demirbas, 2007)(Ayhan Demirbas, 2008)(Liaquat, Kalam, Masjuki, & Jayed, 2010)(Lamers, Hamelinck, Junginger, & Faaij, 2011) -Medium- to long-run, biofuels significantly reduce global CO₂ emissions (through fuel substitution effect and consumption effect (Piroli, Rajcaniova, Ciaian, & Kanacs, 2015) -Reduce landfill site when using waste material as biofuel feedstock (Ellabban et al., 2014) -Biofuel are high in combustion efficiency (Ayhan Demirbas, 2009) -Energy source are biodegradable (Ayhan Demirbas, 2009) 	<ul style="list-style-type: none"> -In the short-run, biofuels may increase CO₂ emissions temporarily, when use (Piroli et al., 2015)(Olah et al., 2009) -Depletion of local water supplies (Ellabban et al., 2014) -Water and soil pollution due to high demand fertilizer usage (Ellabban et al., 2014) -Reduce biodiversity due to water and soil pollution (Ellabban et al., 2014) - In some areas crop-based biofuels may accelerate deforestation due to the expansion of land usage for the cultivation of suitable feedstock (Nasterlack et al., 2014)(Ewing & Msangi, 2009)
Energy security	<ul style="list-style-type: none"> -Provide long term energy security for human being (Shadman, Sadeghipour, Moghavvemi, & Saidur, 2016) -reduce the usage of fossil fuel (Ayhan Demirbas, 2009) 	<ul style="list-style-type: none"> -The cost of technology manufacturing and maintenance (Ellabban et al., 2014)
Socioeconomic development	<ul style="list-style-type: none"> -Employment opportunities in agriculture for rural communities (Ellabban et al., 2014)(Ruiz, Juárez, Morales, Muñoz, & Mendívil, 2013)(Ayhan Demirbas, 2009) -Improve well-being in rural communities create direct, indirect and induce 	<ul style="list-style-type: none"> -Emerging biofuel alliances will extract and process natural resources which will affect subsistence farmers, indigenous peoples, and local people with insecure land rights (Dauvergne & Neville, 2010) -Increasing food prices and

	job, and income creation (Santamaría & Azqueta, 2015)(Cambero & Sowlati, 2014) -Biomass and bioenergy export opportunities (Ellabban et al., 2014)(Ruiz et al., 2013) -Increase investment in plant and equipment (Ayhan Demirbas, 2009) -Reduce dependency on imported petroleum because biofuel available from biomass source (Ayhan Demirbas, 2009)	land-grabs by plantation developer which can resulted in a reduction supply of certain commodities on the world market (Van der Horst & Vermeulen, 2011) - Some conflicts between food, fuel feedstock, and farm feed (crop feed and livestock grazing) (Raman et al., 2014)(Escobar et al., 2009)
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CONCLUDING REMARKS

Alternative energy will become important in the future because they will most likely be part of a portfolio of solutions to address the problem of high oil prices and finite fossil fuel resources. It is expected that due to the limited fossil fuel resources, conservation and the use of other alternative fuels will become more important. Other advantages associated with alternative energy include it will enhance the environmental protection, improve energy security, and increase the socioeconomic. However, there are several drawbacks of alternative fuel technology to be implemented. So, it is important to examine demographic characteristics, physical characteristics (variation in average rainfall, reliance on irrigated agriculture), plant ownership type (absentee vs. local), and community opposition in order to reduce the disadvantages for the implementation.

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