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Biofuel's Sustainable Development under the Trilemma of Energy, Environment and Economy

Zrównoważoność biopaliw w kontekście triady energia, środowisko i ekonomia

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Abstract

Biofuel helps to overcome energy shortages, and to improve the environment, as well as to increase job opportunity. So, on the one hand, biofuel solves the above mentioned problems; on the other hand, it brings new challenges to the fields of energy, environment and economy. The development of biofuel not only needs technological support, but also needs policy guidance. The paper discusses government's policy to support biofuel's development in a sustainable way.

Key words: energy crops, environmental governance, industrial upgrades, sustainability, biofuel policy

Streszczenie

Biopaliwa pomagają przezwyciężyć niedobory energii, przyczyniają się do poprawy stanu środowiska, a także do zwiększenia możliwości podjęcia pracy. Tak więc z jednej strony biopaliwa przynoszą konkretne korzyści, z drugiej związane są nimi nowe problemy w kontekście energii, środowiska i ekonomii. Rozwój biopaliw potrzebuje nie tylko wsparcia technologicznego, ale także odpowiedniego zarzadzania. W artykule omówiono w jaki sposób rządy mogą wspierać rozwój biopaliw w zrównoważony sposób.

Key words: rośliny energetyczne, zarządzanie środowiskowe, innowacje przemysłowe, zrównoważoność, polityka biopaliwowa

1. Introduction

Many factors caused the global food crisis from 2007 to 2008, which include the climate change and despises of agricultural development and the unfair international food trade, the manipulation of giant transnational food incorporations, as well as the worldwide development of biofuel. Due to this crisis, biofuel came into the public's sights and the future of biofuel falls into people's debate. Some people are pessimistic, while some people believe biofuel industry will have a bright future under the premise of a sustainable development. A sustainable development of biofuel must give response to the current trilemma of energy, environment and economy.

The first part of this paper will introduce the definition and classification as well as function of biofuel and the biomass sources of biofuel in some typical regions. The second part will analyze three backgrounds of biofuel's appearance. And the third part analyzes in what extend biofuel solves the three predicaments of energy, environment and economy. The fourth part is the most important one of this paper which puts forward some ideas helpful for the sustainable development of biofuel.

2. A brief introduction of biofuel

The term of *Biofuel* was first used in 1970s (*Dictionary*, 2014). Biofuels are liquid, gaseous or solid hydro-carbon fuels derived from biomass. Biomass refers to any organic matter that is available on a renewable or recurring basis, including agricultural crops and trees, wood and wood wastes and residues, plants (including aquatic plants), grasses, residues, fibers, and animal wastes, municipal wastes, and other waste materials. Biofuel can be used as fuel for automobiles, trains, ships and planes, as well as sources of heat and electricity. In current period, biofuel is mainly used as vehicle fuels. Biofuel mainly include bio-ethanol and biodiesel, biogas, etc. Bioethanol is made of plants containing much sugar or starch, such as sugarcane, sorghum, beetroot, yam and cassava. Biodiesel comes from animal fats such as fish oil or oil plants such as soybean oil, palm oil, sunflower seeds oil, coconut oil, jatropha seeds oil, pongamia, moringa oleifera seeds oil, castor seeds oil or waste oils. World agricultural product statistics will show the top producer of each kind of crops, esp. those can be made to biofuel, for instance, Malaysia and Indonesia produce a large quantity of palm oil and Philippines produce a large amount of coconut.

In fact, developing countries in Asia, Africa and Latin America have a good biodiversity which supplies enough resources for biofuel production. For example, resin cheesewood (with its Latin name *Pittosporum resiniferum*) is a tree that grows in Philippine, particularly in the wilderness surrounding the Mayon Volcano. The tree has another easily remembered name, *petroleum nut*, because of the resemblance of the fruit's odor to petroleum-based fuels. The fruits of the tree can be burnt brightly when ignited, and can be used for illumination as torches or candles (Wikipedia, 2014).The octane value of it is higher than that of jatropha seeds and is thus of great potential for commercialization. American has brought in this kind of Philippine tree to plant in some regions of USA. The global South has a great future for developing biofuel. But the first thing of Global South is to offer enough food and to reduce poverty, and then improve the technology. In order not to snatch food from human beings, global biofuel has undergone four generations' development. The first generation biofuel comes from surplus food or vegetable oil; and the second generation biofuel comes from agricultural waste, forest residue, municipal solid waste, by-products of food industry, fast-growing wood and grass; the third generation biofuel comes from algae; the fourth generation biofuel is made from microorganism. Most countries are in the first stage of biofuel development.

3. Background of biofuel upsurge

3.1. Energy shortage and biofuel upsurge

Energy can be divided into fossil energy, renewable energy and fission energy. Fossil energy includes petroleum, coal, natural gases, etc. Before the wide use of petroleum, German engineer Rudolf Christian Karl Diesel used peanut oil as fuel in late 19th century; and Brazil began to use alcohol made from sugarcane in 1920s and Japanese army used *Indian jatrophac curcus* seeds oil as airplane fuel in WW II, economy of developed countries was thrived with the support of petroleum, that is, the wide use of oil, and thus petroleum as an important resource caused tense relations between western countries and OPEC member states in 1970s.

The pursuit of alternative energy sets a new agenda before scientists and politicians. In 1978, the magazine Science published an article articulating scientists' view that alcohol can be renewable and clear fuel used for transportation (da Silva et al., 1978).USA began a large scale of use of ethanol in Nebraska since 1970s. In the 1980s and 1990s oil crisis broke out twice and till now Middle East is still the turbulent region of world not only because of religious conflicts but also because of oil resources, at the same time South China Sea is attracting more attention of big powers for its rich marine oil. In the 21st century, energy shortage becomes more serious and King Hubbert's famous theory of *peak oil* that the speed of petroleum and gas production may increase to a summit and then decrease rapidly because of the exhaustion of storage adds people's worries. Besides the diplomacy carried by politicians to secure oil supply, alternative energy including biofuel is necessary for the reduction of oil dependency. Thus, the multi-national corporations chanted the slogan of *planting oil in the fields*.

3.2. Environmental degradation and biofuel upsurge

We not only need enough energy but also clear energy. With the rapid developments of industry, environmental degradation is serious. The use of traditional fuels, such as petroleum and coals, emits a lot of CO, CO_2, HC, benzene and particulates, etc. which have contaminated our air, water and even changed the climate, causing abnormal weather, drought, flood, and the disappearance of some islands. Since 1970s, international society is trying to cooperate to improve world environments in order to secure our basic rights to enjoy clear air as well as to get enough and secure water, which is still in the process of negotiation and cooperation. The planting of energy crops can absorb CO_2 through Photosynthesis, and the use of biofuel can reduce emission of harmful gases. Thus scientist will make comparative studies of each energy crops and find the most potential ones to spread.

Even some desert plants such as *Haloxylon ammodendron* (Chinese called *Suo suo*), *Korshinsk Peashrub, sweetvetch, Salix psammophila* etc. can prevent wind and fix sands as well as be used as materials of biofuel. Apart from the function of controlling deserts, some plants can prevent the soil erosion as well as be made into biofuel, such as Black Locust whose seeds can be pressed into oil and *Hippophae rhamnoides* Linn whose fruits can be converted into bio-ethanol. Some other plants can be planted on the abandoned mines or in the acid soil or on the polluted lands such as lands contaminated by heavy metals, and these plants can ameliorate soil and reduce local economical lose as well as supply materials for biofuel. Thailand has planted palm trees in the Rangsit

Site to change the soil acidity (Thailand…, 2008) and planted sugarcane in the cadmium-contaminated Mae Sot district of Tak (Thailand…, 2008). If the energy value of plants can be well combined with its environmental value, energy crops will have a bright future.

3.3. Economy depress and biofuel upsurge

The industrial upgrading also leads to the increase of biofuel production. Since the last half of the 20th century the social productivity has been greatly improved, but agricultural surplus caused the reduction of agricultural profits and hurts peasants. In this condition, Europe changed rapeseeds into biodiesel in 1980s and Philippine converted surplus sugarcane into bio-ethanol and Malaysia converted surplus palm oil into biodiesel. But in 21st century, to develop biofuel can extend the industrial chain and increase job opportunities, esp. when the finance crisis happened. This is why American president Barack Obama said in his inaugural speech: *We will harness the sun and the winds and the soil to fuel our cars and run our factories.*

Nowadays food industries such as palm oil factories or coconut factories not only produce food but also change byproducts of food into fuel. In the countries using Chinese herbal medicines, those enterprises processing herbal medicines can convert parts of the plants such as *Jatropha, Pongamia pinnata,* etc. into biofuel. In the developing countries, governments encourage peasants to plant energy crops so as to reduce poverty, for example, Prime Minister of India, V. P. Singh, considers biofuel development as a part of *Indian National Rural Employment Guarantee Scheme (NREGS)* and Indonesian President Susilo advocated biofuel to reduce poverty; and Thais former premier Thaksin supported biofuel as a part of his *Rural Development Plan*.

With the development of low carbon economy including the development of biofuel, a new term *Green Collar* comes into being. Peasants, researchers, processors, manager, etc. made up the stakeholders of biofuel industry. Except the preferential policies given to the peasants or biofuel processors, the funds put into the research of biofuel is increased. For example, in July 2008 the US Department of Energy offered six universities US $4.4 million in biofuel research funding.

4. New problems biofuel development faces

Biofuel as a new source of renewable and clear energy also offers a new point of economic growth, so few countries are producing or planning to produce biofuel nowadays, which is different from what it is in the late 20th century. But as we all know, anything has two sides, and biofuel can in some extend, though not wholly, respond to the former mentioned three complaints. And in this part we will find in what extend biofuel can answer the three complaints, which is an important factor for us to find a way out towards biofuel sustainability.

Firstly, in what extend biofuel can solve the energy needs. Supply of biofuel materials and level of biofuel technology and rules of biofuel trade will influence the biofuel production and supply. Therefore, some countries supply the materials but do not consume the biofuel or consume less than the developed countries such as EU member states, USA, Japan, etc. In the developing world, biofuel development has more economical meanings such as reducing poverty and increasing foreign exchange rather than solving its own energy needs. According to a statistics, global ethanol production reached nearly 20 billion gallons and global biodiesel production totaled 5.1billion gallons in 2009 (Scarlet, Dallemand, 2011). But the poor technology and lack of compatible equipment reduced the local use of biofuel in developing countries and the trade barriers such as high tariff rates set by developed countries bring frictions between countries and are not favorable to developing countries. For instance, eight countries including Argentina, Brazil, Columbia, Indonesia, Malaysia, etc. wrote to EU, demanding EU cancel the negative clauses concerned with biofuel (Iago, 2008). Compared with biofuel production, many factors caused biofuel consumption to only take up a small portion of energy locally and globally.

Secondly, in what extend biofuel is green. Energy crops are helpful to increase carbon sink and reduce emission of harmful gasses or particulates. However, biofuel development is threatening environment in another way. The spread of some kinds of energy crops that can bring high yields will threaten biodiversity and destroy the ecosystem. Forests are destroyed to spare lands for planting energy crops, which cause the emission of CO_2 to increase, the amount of Indonesian CO_2 emission increased rapidly for this reason. Besides, in order to improve the production amount of energy crops, modified gene technology will be widely used, which will change the structure of species. More water is consumed when planting energy crops. During the processing of biofuel, untreated water will cause pollution. Mark A. Delucchi (2010), Galan-del-Castillo Elena (2010), Ray Huffaker (2010), Winnie Gerbens-Leenesa (2009), R. Dominguez-Faus (2009), Thomas W. Simpson (2008), Charlotte de Fraiture (2008), etc. discussed the water footprint in energy crops planting and biofuel refinery.

Thirdly, in what extend biofuel solves the economical predicament. Biofuel development offered new job positions, however food prices are going up and poor people need to cost much more in their daily life. To enjoy enough and secure food is also a basic human right and shall be secured. But lured by high profits, private companies or large transnational corporations will use good land but not marginal land to plant energy crops, which will effect the agricultural cultivation, esp. when there is a slow progress on the technology of a new generation' s biofuel. This economical enlargement of biofuel will finally affect the social justice.

5. Path to biofuel sustainable development

Biofuel production can cause positive as well as negative effects. The answer of future biofuel development is through sustainable ways. Energical, environmental, economic as well as social factors shall be entirely evaluated when biofuel is developed. Although the standard of biofuel sustainability is not agreeable among countries, there lies some basic consensus.

The Dutch government claims that biofuel development shall consider six standards: *(1). Greenhouse gas balance; (2). Competition with food, local energy supply, medicines and building materials; (3). Biodiversity; (4). Economic prosperity; (5). Social well-being; and (6). Environment* (Piementel, 2008). In August 13th Roundtable on Sustainable Biofuels held by the United Nations Environment Programme (UNEP), EPFL, World Economic Forum, World Wide Fund For Nature, etc. passed an act to define and measure biofuel sustainable standard, and discussed the relation between biofuel development and land protection and labor rights, and biofuel's effect on biodiversity, soil pollution, water resources and food securities. In all, the sustainable biofuel development shall consider the agricultural, ecological, environmental, economic as well as social sustainability. In the local and global level, the sustainability is a principle, and we shall put it into practice.

First, we shall do much more scientific research. A nation shall be familiar with its potentials of biofuel development, and set the proper proportion of biofuel in its own energy plan, to develop step by step but not crazily. A nation shall set a scientific plan of biofuel development. At the same time we shall improve the planting technology of energy crops and biofuel processing technology and reduce biofuel's threat to food security and eco-security. If anyone or any economic actor disobeys the principle of sustainability, it will cause punishment.

Second, do not neglect the spread of knowledge of biofuel sustainability. In some countries, automobile drivers and ordinary citizens are well acknowledged of biofuel due to the good publicity. While in some countries very few people know the new things. If common people are well known about the biofuel, they will find some waste in daily life can be used to produce biofuel; and if officials are well known about it, they will support and oversee the sustainable way of biofuel developments. Funds shall be put into the information construction and proper promotion of biofuel.

At last, international society shall reinforce dialogues and co-operations concerned with biofuel developments until they can agree on the biofuel sustainable standard. Sustainable biofuel standard shall be established on the base of interdisciplinary dialogues. The global world shall as possible as they can to share the experiences of biofuel development and technological advancements of biofuel for seek of sustainability. The global society shall push the fair trade of biofuel to avoid unsustainable development of biofuel in some regions. The publicity through various media such as Internet is important for the increasing of people's awareness of biofuel sustainability.

6. Conclusion

The foregoing examination has scrutinized the backgrounds of biofuel's arising, which include the energy shortages and environmental degradations and industrial upgrades. But biofuel can only in some extant solve the above predicaments. If biofuel can be developed in a sustainable way, it can be more helpful to solve those problems, and this is what the international society is committed to. Local government, private sectors and international organizations, etc. are putting up their standards of biofuel sustainability, which need time to practice, and to proof which standard is most feasible. And as from views of developing countries, the countries' guidance of biofuel development in a sustainable way is important and publicity of biofuel in a proper way is necessary and the participation of negotiation of biofuel trade rule and discussion of biofuel standard of sustainability is also important.

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