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A review on present situation and development of biofuels in China☆

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ABSTRACT

Energy shortage, energy safety, environment pollution and global warming commonly promote the development of biofuels in China. Maize, wheat and rapeseed should be banned gradually as feedstocks. Cassava and sweet sorghum have better environmental benefits for ethanol production and so do jatropha curcas and pistacia chinensis for biodiesel. Evaluation of potential land for the four feedstocks has already been done and they are prior to other sources. Macro polices promote development of fuel ethanol and biodiesel industries. Economic measures including tax cuts, subsidies and compensation mechanisms and sale channels are given to ethanol companies. Rapid development of fuel methanol industry and limited source of feedstocks become the resistance of ethanol industry. Biodiesel can hardly achieve economic supports due to complex sources of feedstocks, variable compositions and different properties. China treats cellulose biomass and microalgae as the best choice for ethanol and biodiesel productions and they are in the research stage.

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1. Introduction

Most of global primary energy production derives from fossil energy [1]. Fossil fuels accounted for 86.7% of the total primary energy consumption in 2013, with 32.9% share for oil, 23.7% for natural gas and 30.1% for coal [2]. China represents the second-biggest economy in the world and accounts for 22.4% (2852.4 million tons oil equivalent) of global primary energy consumption [2]. Moreover, due to the high economic growth ratio, energy demand increases significantly in China.

Transport sector worldwide almost entirely relies on fossil fuels, oil in particular [3]. Unfortunately, this activity is major energy consumption and use most of the limited non-renewable fossil energy that creates a negative impact to living environment [4]. Accordingly, searching for alternative fuels is the core task of Chinese government. The utilization of coal-based methanol as a practical alternative fuel is one of the most realistic options for China, due to the "oil-lean, gas-lacking, and coal-rich" structure of Chinese energy resources [5]. However, coal-based methanol in essence derives from fossil energy and production and use of coal have low energy efficiency and high pollution which are harmful to the environment. Considering both the reality and the future, China takes methanol as the transitional alternative fuel in the recent twenty years and on the other hand greatly develops and promotes electric vehicles and biofuels for traditional vehicles.

Faced with increasing emissions and ever more apparent impacts, governments are using legislation to expedite transitions towards a low carbon economy and to a lower carbon technology uptake [6]. Transport is the most important contributor for greenhouse gas (GHG) emissions, for example, in USA transportation activities (excluding international bunker fuels) accounted for 32 percent of CO_2 emissions from fossil fuel combustion and 27 percent from the total in 2010 [7]. Climate change consciousness has served as an important driver to the embrace of biofuels because it assists climate change mitigation efforts by displacing fossil fuel consumption [8].

☆ Research activities: combustion and emission of engine; renewable and alternative fuels of road transport.

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In 2010 renewable energy used in power generation grew by 15.5% and global biofuels production by 13.8% [9]. Fuel ethanol is widely used in Brazil and US. Both countries together were responsible for 87.1% of the world's fuel ethanol production in 2011 [10]. In 2013, Global biofuels production grew by 6.1%, driven by increases in the two largest producers: Brazil (+16.8%) and the US (+4.6%) [2].

2. Promotion drivers of biofuels

2.1. Energy shortage and energy safety

Fig. 1 [11] shows the number of automobiles, crude oil consumption and dependence on foreign oil in recent years. Fast growth of economy promotes the soaring quantity of automobiles. In 2012 the number of automobiles increases more than five times than in 2004 and reaches 120.89 million, which results in the sharp increase of corresponding demand for crude oil. Supply and demand of crude oil is extremely unbalanced and China's dependence on foreign oil increased from 42.9% in 2005 to 56.7% in 2011 which is so high that the energy safety seriously deteriorates. Additionally, complex international situation makes the situation of energy safety more sensitive and variable. Energy shortage and energy safety effectively promote the development of biofuels.

2.2. Air pollution

The urban air pollution problems caused by the vehicles are attributable directly to the choice of internal combustion engine as the means of propulsion. Biofuels content oxygen which is helpful for complete combustion, thus reducing hydrocarbon (HC), carbon monoxide (CO) and particulate matter (PM) emissions. An example for bio-diesel, cumulative emissions would reduce total 3.4% and 3.7% for PM and CO, respectively; total HC emissions would be reduced by 5% [12,13]. In US, demand for biofuels receives a tremendous boost in the past five years from the fuel ethanol for gasoline vehicles and biodiesel for diesel. This leads to a lowering of harmful pollutants, effectively improving air quality in urban areas. In China, automobiles have already been the major air pollution sources and for example in Beijing their contributions of HC, CO and NO_X are respectively 63.4%, 73.5% and 46%. Severe atmospheric pollution forces the Chinese government to look for clean alternative fuels and biofuels have superiority in reducing HC, CO and PM emissions.

2.3. Global warming

As well as energy consumption, GHG emission has already became a worldwide problem which threatens harmonious coexistence of human and environment, sustainable development of economic, and even survival of mankind. At present, most countries have already realized, that high energy consumption and emission model of economic growth are difficult to continue and the only way is to promote low-carbon economy for sustainable development. In order to meet the challenge of climate change, in the “United Nations Conference on Environment and Development” main countries in the world, signed “United Nations Framework Convention on Climate Change” and the “Kyoto Protocol” for controlling GHG emissions. Since the basic goal of climate policy is to reduce CO_2 emissions from the extensive use of fossil-based energy, there exists a close link between climate policy and energy policy [14]. From Fig. 2 [15], in 2009 the primary energy consumption of China (2210.3 mtoe) is as much as that of US (2205.9 mtoe), however, CO_2 emission from energy consumption of China is 32.8% higher than that of US. Consequently China has the largest responsibility and duty to reduce CO_2 emission through optimizing the consumption structure, such as improving the share of renewable energy and nuclear energy. Biofuels have the obvious advantage over other fuels in reducing GHG emissions through absorption in growth phase of feedstocks.

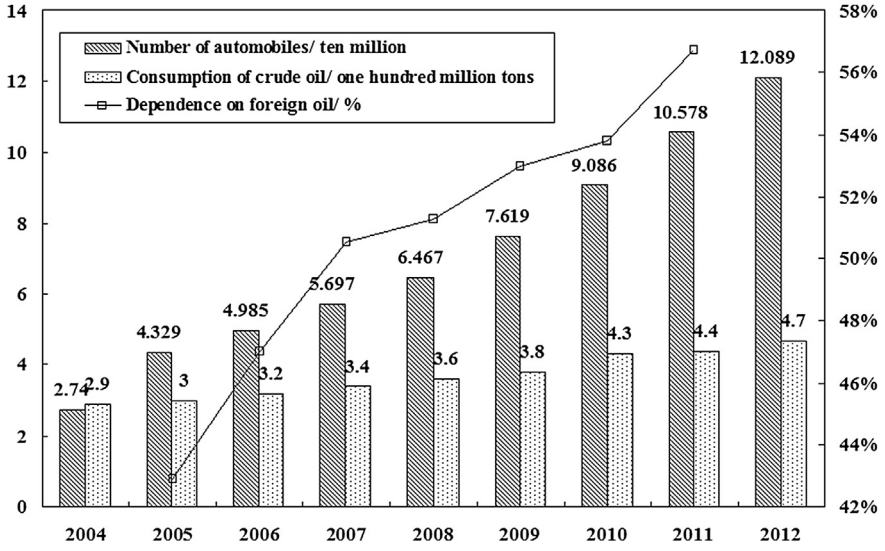

Fig. 1. Statistics of automobiles and crude oil consumption and dependence on foreign oil.

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