Comparison and Reference for the Development Experience of Aviation Biofuel Industry in China and EU

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ABSTRACT

The research and development and use of China’s aviation biofuels is entering into industrialization. Compared with the EU countries, China’s aviation biofuel industry is still in its infancy and its features are high cost, low production and small scale of commercial application. Through the literature review method, this paper studies the development experience of EU’s aviation biofuels from three aspects of legislative support, financial support, and technical support. By comparing the development situation of aviation biofuel industry between China and the European Union and considering the development situation of China’s economy, the paper illustrates the development situation of China’s aviation biofuels and puts forward some suggestions on the development of China’s aviation biofuels from three angles of government support, business support and scientific research support to promote low-carbon aviation development and economic sustainable development.

KEYWORDS

Aviation biofuel, industrial economy, China and the European Union.

INTRODUCTION

In recent years, aviation industry has rapidly developed. Accordingly, its related carbon dioxide and nitrogen emissions also have a significant impact on the climate environment, which has aroused high concern in the whole society. The study found that, the condensation trail of the plane would form a cirrus cloud (a kind of upper cloud), which would impede the emission of heat from the earth's surface, then intensify global warming. Since aircraft mainly release carbon in the stratosphere, the resulting greenhouse effect is much higher than that caused by the equivalent amount of terrestrial carbon emissions. According to statistics, 11% of carbon emissions of the global transportation system comes from the aviation industry, and aircraft weighing more than 60 tons are the main sources of carbon emissions in the aviation industry.

In view of this, all walks of life have been discussing the aviation industry's low-carbon and emission reduction for a long time. The International Civil Aviation Organization (ICAO) passed a landmark Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) in 2016, to address the impact of carbon dioxide emissions on the global climate. In terms of aviation industry, industry competition of alternative aircraft fuels represented by biofuels has kicked off all over the world. All countries have accelerated the development and test work of aviation biofuels and the
European Union (EU) has led the world in this aspect. Since 2011, KLM Royal Dutch Airlines has been using aviation biofuels, and by 2015, the percentage of aviation biofuel use has reached 10 percent overall in Europe (Eurostat, 2016). On February 3, 2017, the European Commission said that, commercial airlines in areas of the EU had cut carbon dioxide emissions by more than 65 million tons between 2013 and 2016. This achievement has benefited from the support of the EU in various aspects including technology, system and policy.

The sustainable development of China's aviation industry has been put on the agenda. The research and development and use of aviation biofuels is entering into industrialization. From 2011 to 2015, Civil Aviation Administration of China (CAAC) has promoted over 1200 energy conservation and emission reduction projects in eight major categories in the whole industry, with a total investment of nearly 13.5 billion yuan. In 2015, the oil consumption of CAAC’s aircraft was 0.294 kg per ton-kilometer, down by 13.5% compared to 2005. On November 3, 2016, Hainan Airlines released first research report focusing on the green development in the domestic aviation industry – White Paper on Green Aviation in 2016, to guide the domestic aviation development to service-oriented, safe and green model. In 2015, the opening of first air route with aircraft using aviation biofuels (Shanghai Hongkou airport - Beijing Capital airport) marks that China has stepped in commercializing aviation biofuels.

Compared with the EU countries, whether in the technology, system or policy support, the road to low-carbon and environmental protection in the China’s aviation industry, especially large scale and commercialization of aviation biofuels, is still in its infancy. The drawbacks of China’s aviation biofuels include high cost, low production and small scale of commercial application, which may be improved by technical breakthroughs and greater policy support. China's carbon market will be officially launched in 2017, which will directly affect the transformation of traditional aviation fuels into aviation biofuels. With the control of carbon emissions from countries around the world, China needs to strive to develop its aviation biofuel industry.

LITERATURE REVIEW

To develop China's aviation biofuel industry, learning development modes of aviation biofuels in advanced countries is of great significance.

Junying Chen and others introduced characteristics, raw materials, production methods and utilization status of aviation biofuels, and pointed out that using microalgae to produce aviation biofuels is the main direction of future research, but mass production is technical bottleneck (Junying Chen, etc., 2012). Jitao Yun and others discussed the feasibility of linking aviation biofuels with CDM project, thinking it can promote the aviation industry to use aviation biofuels and offset some of the carbon emission tax at the same time (Yitao Yun, Wenhua Wang, 2013). Qun Luo and others analyzed the development scale of aviation biofuels in various countries, and pointed out four major challenges faced by China's development of aviation biofuels: 1. high cost; 2. immature production technology; 3. lack of stable and sustainable raw material supply; 4. squeezing agricultural resources, or competing with food land (Qun Luo, Hui Wang, 2012).

The current literature review about aviation biofuels mostly concentrates on the level of technology and market, such as the technical route research on production of aviation biofuels, cost analysis of aviation biofuels and so on. However, the
comprehensive and comparative research on development modes of aviation biofuel industry is almost blank.

**DEVELOPMENT SITUATION AND EXPERIENCE OF AVIATION BIOFUEL INDUSTRY IN THE EU**

The European Union is the most developed region in the global aviation biofuel industry, which is inseparable from its scientific development model.

**Development Situation of EU’s Aviation Biofuel Industry**

The EU now has more than 1,500 flights using aviation biofuels, which can reduce carbon emissions by up to 80 per cent compared with conventional fossil fuels (ATAG, 2014). According to 2012 flight database records, since June 2011, KLM Royal Dutch Airlines as Europe's first company using aviation biofuels, had four flights every day in route Paris - Amsterdam B737 and 26 flights every week in route Amsterdam - New York's JFK, a total of 200 flights.

As of 2013, 1187 flights had carried out flight records and tests for more than six months. These include Finn Air, Iberia Airlines, Thomson Airways, Air France, Norwegian Air Shuttle and SAS (Scandinavian Airlines Systems). The European Commission closely coordinate with aircraft manufacturers, operators and biofuels producers in Europe and signed the European Advanced Biofuels Flight Route in 2011, which was an industry initiative within the scope, aiming to accelerate the expansion of European aviation biofuel market. The EU market is expected to produce 2 million tons of sustainable aviation biofuels by 2020.

**EU’s Successful Experience in the Development of Aviation Biofuel Industry**

**SETTING UP A LEGAL FRAMEWORK TO SUPPORT THE DEVELOPMENT OF AVIATION BIOFUELS**

The European commission adopted Renewable Energy Directive (RED) in April 2009, and began implementing it in December 2012, setting up a basic legal framework for the development of renewable energy in the EU. The basic aim of the legislation is: by 2020, the average share of renewable energy of the EU Member States will have accounted for 20% of total consumption of energy. And the legislation stipulates that each member’s share of renewable energy in energy consumption of transportation must be up to 10%. Biological liquid fuels are regarded as the main approach to produce renewable energy for transportation, and the target contribution rate reaches 90%.

At the end of 2010, under the framework of RED, the EU put forward a goal for greenhouse gas emissions. Namely, by December 31, 2020, compared with 2011, greenhouse gas emissions in life cycle from the transport fuels per unit will reduce by 10%, 6% of which needs to be realized by the use of advanced biofuels. Its purpose determines the low-carbon and sustainable development direction of biofuels once again.

In order to speed up the implementation process of sustainable standards for biofuels, the Europe Commission encourages member countries and international organizations to enact and implement national sustainable standard plans according to
the sustainable development requirements of RED. All biofuels sustainable standard plans must meet the following requirements: (1) lowest greenhouse gas emissions standard (article 17 (2) of RED): compared with fossil fuels, the lowest emissions standard is 35%, and the lowest emissions standard can reach 50% in 2017, 60% in 2018; (2) the land utilization and ecological protection requirements (article 17 (3) - (5) of RED): tropical rain forest and natural grassland and nature reserve with unique ecological environment shall not be destroyed, regional biodiversity must be protected, and forest or areas with higher carbon content like peat land cannot be used to produce raw material of biofuels; (3) using the mass balance system to track fuel production chain all the way (article 18 (1) of RED): various stages of fuel production chain should be monitored and tracked all the way, including raw materials production, fuel production to filling use of gas station, etc., to ensure the realization of sustainable biofuel standard.

RED required Member States to put forward national renewable energy action plan by June 30, 2010. Britain implemented Renewable Transportation Fuel Obligation, (RTFO), Germany implemented Biofuel Quota Act, (BQA), Switzerland implemented Biofuels Life Cycle Assessment Ordinance, (BLCAO), Netherlands carried out Transport Biofuels Act, (TAB), and Denmark implemented Sustainable Biofuels Act, (SBA).

The enactment and implementation of these bills have provided a solid institutional basis for the development of aviation biofuels, forcing airlines to reduce carbon emissions and increase their use of biofuels.

COMPREHENSIVE FINANCIAL SUPPORT AND SUBSIDY POLICY SYSTEM

1 Supporting the development of biofuels through land fallow subsidies

In order to reduce the surplus of agricultural products and enhance the international competitiveness, EU reduces expenditures and carries out Common Agricultural Policy (CAP) reform. Meanwhile, it compensates producers of the grain and oilseed crops according to the proportion of fallow land. But after 1993, many countries allow to grow crops for energy in fallow land, such as non-staple energy crops. According to statistics, 95% of non-staple crops are planted in fallow land, which indirectly supports the development of biofuels. From 2000 to 2002, according to the statistics, fallow subsidies have been 290 euros per hectare on average. If we estimate that non-staple crops producing biofuels account for 70% of fallow land, indirect subsidies to biofuels reached about 0.26 billion euros in 2005, about 1 billion euros in 2010.

2 Supporting the development of biofuel industry through energy crops plan implementation

The Energy Crop Scheme, as a part of the EU’s CAP reform in 2003, is one of the EU’s key initiatives to support the development of the biofuel industry. 45 euros per hectare are paid to farmers who produce energy crops. With the expansion of planting area, land areas farmers applied for compensation reached 1.84 million hectares in 2009, 70% to 80% of which were used for biofuel crops. Because of the high production of biodiesel in the EU, the support proportion of rapeseed is higher, and the total expenditure for supporting rapeseed in 2006 reached 37.8 million euros.

3 Supporting the demonstration project through project subsidy

Capital support mainly focuses on demonstration projects. For instance, Belgium (environmentally friendly investment projects preferential tax) and Poland (state
environmental protection and water management fund) are mainly supported by environmental protection departments. Cyprus (energy conservation plan and scheme for the promotion of renewable energy), Germany (planned demonstration project support of renewable energy in 2005 and 8 million euros for current demonstration project’s yearly budget), Ireland (national renewable energy projects subsidies) and Portugal (ENERGIA and MAPE/POE plan), Spain (energy saving and efficiency plan) is issued by Renewable Energy Committee. And Czech Republic (the Ministry of Agriculture has preferential loans to buy technology) is supported by the Ministry of Agriculture. Austria (Austrian rural development plan), Estonia (national development plan) and Latvia are supported through their development policies in rural and resource-poor areas. Denmark (it supports the research and development for second-generation biofuel and sets up special funds), Greece (competitive operating plan supporting the investment on environmental friendly projects), and the Netherlands (from 2006-2010, it supports 60 million euros) support biofuels by technology which can improve international competitiveness. The UK has adopted Regional Selective Assistance (RSA), and issued Enhanced Capital Allowances (ECA) in 2005, to support the production of domestic biofuels, with the government spending about 800 million euros. Sweden supports the construction of petrol stations through investment finance plan, with a total budget of 16.4 million euros as of December 2009.

4 Subsidizing for the raw materials of biofuels

According to the EU’s CAP, as well as the single-family payment scheme, farmers can get a lot of compensation for growing energy crops. In 2004, the subsidy was about 61.5 million euros. In addition, there are subsidies for raw materials from the state. Since 2001, Czech Republic has used the national agricultural intervention fund to buy rape from fallow land and sell it to producers, making the price of the final product as cheap as 90 percent of the price of gasoline or diesel. During the period from 2003 to 2004, the government of Latvia had paid a total of 105,000 euros to compensate enterprises which use oilseeds for biofuel production because of the price difference at home and abroad. Lithuania subsidizes 46.34 euros for rape per ton to promote the conversion of biofuels. Polish farmers can get capital subsidies from local governments for biofuel material, about 46 euros per hectare.

BUILDING A TECHNICAL SUPPORT SYSTEM

1 Implementing the EU’s science and technology framework program and focusing on supporting the development of second generation biofuels

In the EU, the support for research and development comes from the European Commission and from public and private sectors of many countries as well. European Frame-work Programs aims to support research and technology development as well as demonstration projects. In the sixth framework plan between 2002 and 2006, total support capital amounted to 1.75 billion euros, of which 68 million were used to support the development of second-generation biofuels. There were 14 demonstration projects, with total fund reaching 89.1million euros, nearly 50 percent of which supported the technology of second-generation biofuels. The total budget of the Seventh Framework Program for Research and Innovation (Fp7) is 5.32 billion euros. Between 2007 and 2013, there were totally two first-generation biofuel projects, eight second-generation biofuels demonstration projects, and other projects involving biological refining, biofuels for transportation, biomass resources, and sustainable evaluation and so on. In
order to perform the sixth and seventh framework programs, the EU also enacted Competitiveness and Innovation Program (CIP). And the Intelligent Energy-Europe Program aims to encourage the use of new energy and renewable energy to improve energy efficiency.

2 Setting up National Research Program to support new methods and new raw materials of biofuel production

Much of the research work of EU Member States is done under the support of governments. More than half of Austria's research and development spending is provided by the government, and the rest comes from a number of universities and research institutions. The Danish government mainly supports the development of cellulosic ethanol and intends to lay the foundation for the commercial production of ethanol from agricultural organic waste and forest industrial waste in the next 15 years. Its research work is mainly supported by the Danish Energy Agency and its Energy Research Program (ERP). From 2001 to 2005, the program’s cumulative support capital amounted to 2.56 million euros. Germany has raised 6.8 million euros in biofuel demonstration projects for biofuel research and development and transportation. The total project cost reached 13.2 million euros. France's research and development work was supported by Agriculture for Chemical and Energy (AGRICE), and from 1994 to 2005, the cumulative support capital amounted to approximately 217.2 million euros. In addition, National Program for Research on Bioenergy started in France in 2005. 23 demonstration projects were supported with a total cost of 43 million euros, among which 16 million euros were from public policy support.

THE DEVELOPMENT SITUATION AND THE MAIN APPROACH OF CHINA'S AVIATION BIOFUEL INDUSTRY

The Development Situation of China's Aviation Biofuel Industry

According to the expectation of International Air Transport Association, by 2020 the fuel quantity of China's civil aviation aircraft will up to 40 million tons. And aviation biofuels will reach about 30% of the total amount of aviation fuel, namely 12 million tons. In accordance with the calculation of 10,000 yuan per ton, by 2020, the aviation biofuel market value of China's civil aviation will exceed 120 billion yuan and the market prospect is broad.

However, due to various reasons, China's aviation biofuel industry is still in the insufficient state of development. There is an urgent need for an industrial reform. In recent years, the international crude oil prices continued to decline. Under the guidance of national fiscal and taxation policies, China's biofuel industry gradually transfers to the comprehensive use of non-grain economic crops and cellulose raw materials, and actively carries out the construction of craft and demonstration projects. White Paper on China Industrial Biotechnology in 2015 released by Chinese Academy of Sciences shows that in 2014, China's annual biofuel ethanol production reached about 2.16 million tons. The annual output of biodiesel was about 1.21 million tons (Petro China, 2015). In February 12th, Civil Aviation Administration of China issued CTSOA of No.1 aviation biofuel to China Petrochemical Corporation, which marks the domestic No.1 aviation biofuel officially gains the airworthiness approval and can be put into commercial use. On March 21, 2015, the first commercial passenger flight using No.1 aviation biofuel successfully took place. China independently researched and developed
and produced the aviation biofuel. The main obstacles for commercial application of China's aviation biofuel are that raw materials cannot achieve long-term low-cost large-scale supply, which requires both technical breakthroughs and the government's policy support. Overall, China's aviation biofuel industry is still in its infancy, which mainly reflects in these areas, such as small scale, difficulty in the mass production and low market share.

The Main Approach to Develop China's Aviation Biofuel Industry

In December 2012, the National Energy Board set up two biofuel standardization industrial technical committee, which is Biological Liquid Fuel Processing Standardization Technical Committee and Non-grain Raw Material Energy Industry Standardization Technical Committee. It is expected to rely on the platform of the standard committee to develop relevant sustainable development standards of non-grain biomass materials, marginal land and so on. In addition, the Chinese government is studying the introduction of Biomass Raw Material Base Construction Management Approach, to achieve sustainable production and management of biofuel raw materials from the source of base construction. At the same time, the Chinese government is studying the introduction of non-grain fuel production plan management approach and economic subsidy policy. At present, China mainly conducts environmental assessment and audit in the biofuel project approval stage. This only restricts the project construction. During the industrial development, it cannot achieve the effect of environment guidance and tracking of the full fuel chain. Therefore, the development and application of the sustainable standard of the whole fuel chain is the necessary foundation to ensure the long-term healthy development of the industry.

THE ADVICE FOR THE DEVELOPMENT OF CHINA'S AVIATION BIOFUEL INDUSTRY

China is a country with a large population but very limited arable land. Not only the natural ecological environment has been destroyed for a long time, but also the existing agricultural production itself put on a relatively large pressure on the water quality and soil pollution. Therefore, with the development of biofuels, China needs to increase the importance of sustainability to a new height. This requires the government, enterprises, institutions of higher learning, research institutions and non-governmental organizations to achieve multi-party cooperation, extensive exchanges and early establishment of relevant specific standards and systems.

Government: The Establishment of Planning Objectives and Supporting Policy System

The Chinese government should draw on the practice of the EU and scientifically enact long-term development plan and concrete implementation plan for biofuels. Objectives implementation is supervised, and policies are adjusted in a timely manner to ensure the realization of objectives. At the same time, the government should introduce systematic supporting policy for biofuels, including special funds of research and demonstration, loans preferential policies, tax incentives, etc., to guide farmers,
enterprises and other stakeholders to produce and use bio-fuels and achieve the production of sustainable raw materials and fuels.

**Enterprises: The Establishment of Aviation Biofuel Sustainable Development Model**

Relevant industry leaders should work with countries to set up biofuel sustainability standards and actively support the implementation of standards and policies. Enterprises should produce biofuels strictly in accordance with sustainable production requirements and are actively involved in biofuel sustainability certification. They should explore the biofuel sustainable development model, such as the establishment of low-carbon logistics, large-scale and high-efficient cultivation of raw materials and so on.

**Research Institutions: Breaking Through Technical Bottlenecks and Reducing Production Costs**

Research institutions should research and develop advanced biofuel technology to reduce the cost of aviation biofuel production and provide technical support for enterprise, which truly combines production, study and research to serve for enterprises. Under the guidance of good production practices, research institutions should cooperate with enterprises to carry out large-scale energy crop base experiment like breeding, planting, field management, collection and storage. In addition, they need to develop national biofuel research and development and demonstration routes, while breaking through the key technology needed for sustainable production of biofuels.

**REFERENCES**


