Biofuels in China: Development Dynamics, Policy Imperatives, and Future Growth

By Caleb O'Kray and Kang Wu*

Introduction

Despite controversies over food security and land availability, biofuels are established concepts in the field of energy[1]. Environmental consciousness[2], high oil prices, and other problems associated with fossil energy have brought biofuels to life from the backburner. Developed (e.g. the United States, Canada, and European Union) and developing nations (e.g. Brazil, India, and China) alike have turned to biofuels with high hopes for a partial solution to their growing demands for transportation fuels. Only time can dictate whether biofuels will live up to their hyped expectations. Individual countries have created incentives to research, develop, and manage biofuels differently.

China is currently the second largest energy consuming country in the world after the U.S. Its energy consumption is heavily dominated by coal and other fossil energy, which are non-renewable in nature and more polluting than renewable energy. China is in need of expanding its renewable energy use and finding alternative fuels to power the rapid growth of the economy in general and the transportation sector in particular. Under these circumstances, biofuels present some unique opportunities for China to manage—along with the use of other renewable energy—its over dependence on fossil energy.

This article examines China's biofuels development at present and in the future, policies, and obstacles. China's approach to biofuel development may be an important lesson for others attempting to develop biofuels in their own countries. China has already solidified itself as a major world player in biofuels, trailing only behind Brazil and the US in net biofuel production and consumption and is ahead of other countries.

Biofuels Development in China: A Snapshot

China has dabbled in biofuel production for the past two decades. Their efforts in research and development are paving the way for wide-scale biofuel expansion throughout the country. Recent food security concerns, however, have somewhat stymied biofuels production in China. China's biofuel situation reflects its domestic energy, security, economic and agricultural policies.

Ethanol

While China had the same objectives for pursuing biofuel development, ethanol and biodiesel have taken distinct paths. Research, policy, and implementation have come at different phases. The agriculture, technology, and end-product uses are vastly different for ethanol and biodiesel. As such, it is best to deal with them separately, although they do share beginnings.

The initial phase focused on the research and development of relevant technologies for biofuel production (1986-2001). Research focused on ethanol, fermented methane gas and biodiesel. The National High Technology Research and Development Initiative (which became known later as Plan 863) provided the funds and incentives to undertake this research. Plan 863 was enacted in March of 1986. The general plan studied six varied and yet interrelated sectors: telecommunications, automation, biotechnology, energy, new materials and ocean development. Scientists at the Chinese Academy of Social Sciences led the research team; China's Ministry of Science and Technology provided guidance for the research focusing on ethanol and biodiesel development.

Ethanol development in China occurred in three subsequent phases: (1) a demonstration period (1986-2001); (2) legislative infrastructure, including financial incentives (2001-2004); and (3) enforcement, accompanied by pilot programs that gradually expand, if successful (2004-present).

1. In the demonstration period, the Tianguan Group, based in Nanyang, Henan Province, launched a 200 thousand metric tons (tonnes) ethanol production testing. The central government chose Nanyang for the demonstration because its large wheat surplus presented a prime feedstock for ethanol. From this demonstration project sprung a pilot program for blending ethanol with transportation gasoline in three Henan cities: Zhengzhou, Luoyang and Nanyang. The National Development and Reform Commission (NDRC), the state's central planning commission, and

* Caleb O'Kray is an Agricultural Economist with the U.S. Department of Agriculture. Kang Wu is a Senior Fellow in the Research Program at the East-West Center, Honolulu, Hawaii. The authors wish to thank Shi Fu for his research assistance and Lijuan Wang, for sharing her views and expertise on the subjects. All remaining errors, however, are the sole responsibility of the authors.
See footnotes at end of text.

the China Petrochemical Corporation (Sinopec) supervised this demonstration process.

2. The legislative phase introduced ethanol standards and a legal system that stipulates production, transportation and sales. On April 2, 2001, China released regulations Denatured Fuel Ethanol and Bioethanol Gasoline for Automobiles, establishing E10 production standards. A year later on March 22, 2002, the government began to enforce the Law Concerning Testing for the Use of Bioethanol Gasoline for Automobiles, launching a model to introduce E10 into strategic areas of China. The Bioethanol Utilization Plan was included in the 10th Five-Year Program (2001-2005), establishing a legal system for biofuels and for the relevant raw materials required.[3] The system regulates ethanol production, transportation and sales.
3. Following the pilot programs, on February 10, 2004, China announced its Law Concerning Testing for the Extensive Use of Ethanol Blended Gasoline for Automobiles and the Regulations Concerning the Conduct of Testing for the Extensive Use of Ethanol Blended Gasoline for Automobiles. This marked the beginning of phase three. All relevant conditions for extension of the pilot program made this incremental step forward possible. Logistics, sales, and production were all satisfactory at the small scale.

At the start of 2009, China's four initial and four additional ethanol projects had a total capacity of 2.2 million metric tons (tonnes) or some 47 thousand barrels per day (kb/d) in the four provinces, one autonomous region, and one municipality: Heilongjiang, Jilin, Henan, Anhui, Guangxi, and Chongqing (Table 1). The actual ethanol production in 2008 is estimated at 35 kb/d, indicating a relatively high utilization rate.

The use of E-10 gasoline in China is currently promoted in some regions, including five provinces—Heilongjiang, Jilin, Liaoning, Henan, and Anhui—as well as selected cities in Hubei, Hebei, Shandong, Jiangsu, and Guangxi provinces. By the end of 2010, ethanol gasoline is expected to be used in all provinces except for Tibet, Qinghai, Gansu, Ningxia, and Shanxi provinces/autonomous regions. For ethanol blending, 10% is the norm at present.

Biodiesel

There is a rising demand for biodiesel since the Chinese diesel market is twice that of the gasoline market. Commercial viability is the largest constraint on biodiesel production. China is a net importer in all the major edible vegetable oils, the largest importer in the world. Locally produced feedstock is expensive to come by and the lack of it inhibits large scale commercial production.

Coupled with the lack of fatty organic matter, the lack of land upon which new crops could grow exacerbates the difficulty of biodiesel production. As a result, China produces more ethanol than biodiesel. In May of 2006 China took some preliminary steps toward biodiesel promotion by setting up a special development fund to encourage research, development, and production. Biodiesel's future in China relies on three key factors:

1. Government support and NDRC defining a clear plan for biodiesel production and relevant feedstock harvesting
2. Research and development to solidify technologies for production.
3. Defining and obtaining key organic sources for production. Potential inputs include rapeseed, Jatropha nuts, switchgrass, sunflower seeds, Chinese pistachio, peanuts, sesame seeds, Barbados nuts, Fufang vines, Yousha bean, and Chinese dogwood nuts.

China has a large and growing biodiesel producing capacity. At the start of 2009, China had a total of some 2.1 million tonnes, or 41 kb/d, of biodiesel producing capacity (Table 2). Compared to ethanol, the biodiesel projects are smaller in size and more scattered with much lower utilization rates. In fact, the 2008 biodiesel production is estimated at 6 kb/d only, with a utilization rate well below 20%.

Government Policies

Central government financial incentives have made biofuel production viable. The incentives can be summarized as follows:

- Four initial ethanol projects were supported by the government with subsidies. Up to now, most ethanol was produced from grain in China. The government subsidy on grain-based ethanol production has been reducing annually, from 1,883 yuan per metric ton (tonne) in 2005 (US$29.0 per barrel (bbl)), to 1,628 yuan/tonne (US$25.7/bbl) in 2006 and 1,373 yuan/tonne (US$22.7/bbl) in 2007. In 2008, the subsidy stopped completely.
- The government has started support for selected new biodiesel projects and new ethanol projects

using non-grain as feedstock.
- Same prices as comparable gasoline are enforced by government to make sure that consumers do not pay extra for gasohol.
- The consumption tax that applies to conventional gasoline is waived for ethanol gasoline.
- Ethanol projects using non-grain feedstock are encouraged.

For the last part of the incentives listed above, the NDRC has banned any expansion of projects or new projects using grains as feedstock, while cassava, sweet potato, and sweet sorghum will be used for ethanol, and various oily seeds will be used for biodiesel. By 2010, pilot ethanol projects using sweet sorghum will be established in Northeast China, Shandong Province, and other places, while cassava and sweet potato based pilot ethanol projects are to be set up in Guangxi, Chongqing, Sichuan, and other provinces. Among these feedstock materials, some research indicates that cassava has the potential to become an efficient and attractive crop for fuel ethanol production in China.[4] For biodiesel, projects using oily seeds will be established in Sichuan, Guizhou, Yunnan, Hebei, and other provinces.

In the foreseeable future, the government will dominate ethanol development. Thus, while there are countless local and small private natural ethanol production plants in China producing food grade alcohol, the four original fuel ethanol production plants are all run by state-owned enterprises. By fiat, these producers can only sell their products to Sinopec and CNPC, the two state-run petroleum companies. Sinopec and CNPC then blend the ethanol with gasoline and distribute E10 to gas stations. Over half of the gas stations in China are in the hands the two state oil companies. The state dominates ethanol production. It is reasonable to expect public awareness and consumer demand to have lesser roles in both the short and medium term.

Future Growth of China Biofuels Development

On March 20, 2008, China announced its latest 11th Five-Year Program on Renewable Energy Development[5] with a target of increasing the production of non-grain based ethanol to 44 kb/d by 2010. Earlier, on August 31, 2007, the NDRC released the Mid- to Long-Term Development Program for Renewable Energy for the next 15 years.[6] The 2020 targets are to increase the use of fuel ethanol to 218 kb/d and biodiesel to 40 kb/d by 2020.

Currently, China has various ethanol projects with a combined capacity of 9.2 kb/d under construction and more projects with at least 111 kb/d of total capacity are planned. For biodiesel, nearly 130 kb/d of additional capacity may be added, which are either under construction or planned.

While there are many budding industries and sources of biomass energy in China, in the long-term, economic feasibility will be the determining factor. Prices and profitability will determine the optimum feedstock for production locations throughout the country.

In China, fuel ethanol is profitable when oil prices approach 6 yuan/liter (US$3.32/ gallon).[7] Content requirements and the influence of state owned purchasers of biofuel will continue to define national demand. The policy direction articulated by an NDRC report in May of 2006 was to expand supply by requiring ethanol use in three national municipalities (Beijing, Shanghai, and Tianjin) and expand demand through government sponsored constructing of new ethanol production plants, including one in Guangxi Province (cassava-based) and one in Hubei Province (rice-based).

The demand for denatured ethanol is determined by central government policies, including required production of E10 by the two national oil companies and monthly demand quotas for each of the fuel ethanol producers set by the oil companies.

China has launched sorghum-based ethanol production on a trial basis in Heilongjiang, Inner Mongolia, Shandong, Xinjiang and Tianjin. Presently the trial project in Heilongjiang is capable of producing 5 thousand tonnes of ethanol a year. Sorghum-based ethanol will remain in the testing stages until technology and efficiency bring the product up to par with competing raw materials. There is some question, however, whether the domestic supply of sorghum, cassava, and sugarcane can meet the demand to produce the targeted 218 kb/d of fuel ethanol by 2020.[8]

Obstacles for Biofuels Development

The greatest obstacles restraining biofuel development in China are uncertainty of oil prices, feedstock supply, and government policies. The biofuels industry is presently married to government support. Government policies have delivered contradicting messages, leaving many investors and developers at odds.

Commercial feasibility, contingent upon conventional petroleum prices and technological advances, continues to pose a problem for widespread biofuel production.

Land limitations and food security loom large for China. With their unique history, the Chinese desire to secure food supplies for their population. Despite the many variables involved in the biofuel production equation, arable land availability is one of the few constants. Regional water scarcity issues have pressured officials into thinking twice before unilaterally expanding feedstock and biofuel production.

In addition to the above, oil price volatility creates another huge uncertainty. Although in the long run overall oil prices are moving higher, history suggested that they may still drop at times, which can render some biofuel investment projects uneconomical, and thus slow down the progress of biofuel development.

6. Conclusions

The importance of biofuels has been growing in China's energy strategy and development. In the next five years and beyond one can expect the central government to further tighten its grip on biofuel development. Private production and trade is not entirely out of the question in the long-run. Ethanol production in China will increase, but it has already hit a growth snag with the exhaustion of surplus grain stockpiles and the challenges are high to develop non-grain crops. Commercial biodiesel production will continue to lag behind commercial ethanol production until it achieves greater state backing (both political and financial) and until biofuel science discovers an optimum feedstock for profit and energy efficiency.

Overall, the increasing emphasis on renewable energy as an alternative source to conventional energy, for both policy support and investment helps to create a favorable environment for biofuels development in China. However, land and water limitations, and oil price volatility, coupled with political will, in the face of potential economic losses, pose some of the largest constraints for biofuel development in China, as well as in other countries wanting to develop biofuels. Biofuel development may alleviate some rural poverty and increase national energy independence, but market and scientific uncertainty enshrouds China's biofuels future.

Footnotes

[1] See, for example, Lailas, N, 1989, "Advancing Biotechnology Acceptance in the USA: the Department of Energy's Regional Biomass Program", Biomass 19 (3): 195-213; and

[2] See, for example, Schnoor JL, 2006, "Biofuels and the Environment", Environmental Science & Technology 40 (13): 4042-4042.

[3] See http://www.depthai.go.th/go/content/download/attach?contentId=15838&name=china ethanol.ppt, accessed on February 1, 2008.

[3] See Jansson, C. et al, 2009, "Cassava, a Potential Biofuel Crop for (the) People's Republic of China, Applied Energy, 60 (2009): S95-S99.

[5] See http://www.sdpc.gov.cn/nyjt/nyzywx/W020080318390887398136.pdf, accessed on September 20, 2009.

[6] See http://www.china.com.cn/policy/txt/2007-09/04/content_8800358.htm, accessed on September 15, 2009.

[7] On October 1, 2009, #93 gasoline in Beijing was sold for 6.28 yuan/liter (US3.48/gallon).

[8] Based on the un-used land potential, Tian et al's preliminary estimates show that China could potentially produce 22 million tonnes (479 kb/d) of ethanol. Similarly, the biodiesel production potential is 0.5 million tonnes (98 kb/d) by using winter idle land and cottonseeds. It is, however, unclear how the un-use land potential can be transformed to actual producing capability. For further information, see Tian, Y., et al, 2009, "Estimation of the Un-Used Land Potential for Biofuels Development for (the) People's Republic of China, Applied Energy, 60 (2009): S77-S85.