

THE POTENTIAL FOR ETHANOL FUEL IN CHINA

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Introduction

Energy and transportation issues are critical challenges for China's development. As the Chinese living standard has risen, car purchases have increased rapidly. Over the past decade, the number of private cars in China has increased at an unprecedented rate of 14 percent on average and 40 percent for 2002 (Kim and Qiang 2004). Furthermore, it is estimated that there will be 150 million private cars in China in 2015, twenty times more than the number on the road today.

Currently, most Chinese vehicles are produced domestically with only a small percentage of imports. Several Chinese car companies have begun selling vehicles to some countries in the Middle East as a trial run for exports (Dyer and Mackintosh 2005). However, as the Chinese attempt to enter car markets in developed countries, they still face a series of obstacles, such as the need for improved skills in design, branding and marketing.

The rapid growth of the vehicle fleet has had major energy, environmental and economic impacts. Oil consumption has grown dramatically in recent years. Since 1993, oil imports have exceeded exports from China and since 2000, crude oil imported by China has exceeded 70 million tons. It is predicted that the country's imports will be greater than 100 million tons (equivalent to Kuwait's crude oil output) by 2010 (Rongchun 2002). With oil prices at all time highs, a heavy reliance on imported oil will necessitate significant spending on oil imports. Additionally, this raises security issues since oil imports to China must cross the highly vulnerable Strait of Malacca. Also, the rapid rise in demand implies a need to secure oil supplies from around the globe. This could potentially result in intense competition with the United States (US) for resource

access and strain relations with western countries as China secures oil resources in unstable countries such as Sudan.

Air pollution has been a major concern for most of the large cities in China and is a potential issue for rural areas. Beijing, Shenyang and Xian are the three most polluted cities in the world and 500 major Chinese cities have air quality below the World Health Organization's (WHO) guidelines (Kim and Qiang 2004). Among the cities in China where air pollution is monitored, two-thirds of urban air pollution exceeds government standards. Poor air quality contributes to health problems such as asthma and cardiopulmonary disease resulting in premature mortality and chronic ill health.

Currently, carbon dioxide (CO₂) emissions from transportation in China account for only eight percent of the country's total. However, the rapid growth of vehicles may result in CO₂ emissions from automotive vehicles accounting for 30 percent of the country's total by 2030. China will soon be the world's largest CO₂ emitter. If emissions from the transport sector continue to grow at the current rate, there could be serious consequences for global climate change. This could have negative consequences for China as its coastal areas, the most important areas for China's economy, are most vulnerable to impacts of climate change such as sea level rise and severe weather.

Benefits of Ethanol

Ethanol fuel has been considered as one of the solutions to both energy and environmental health problems in China. Ethanol fuel, produced from corn, or other plants, can reduce petroleum use by about 95 percent and greenhouses gas emissions by about 13 percent. The use of clean-burning ethanol reduces the emissions of air pollutants

such as volatile organic compounds (VOCs), which may cause lung disease. Therefore, use of ethanol has the potential to reduce fossil fuel dependency, improve air quality and public health and improve the living standards of farmers by helping stabilize grain prices and raising farmers' incomes. Furthermore, according to research conducted at the University of California-Berkeley, production of ethanol from grasses and other “cellulosic” biomass sources could reduce greenhouse gas emission as well as provide a sizeable fraction of the fuel needed for transportation in the United States.

In China, using ethanol to substitute oil fuel has been considered as feasible. Ethanol fuel is now produced by the Tianguan Group Company with a production capacity of 200,000 tons of ethanol a year in Henan plant and another plant in Heilongjiang. A third plant is under construction in Jilin Province with an expected production capacity of 800,000 tons. All three plants produce the fuel from corn.

All vehicles can run on gasoline blended with up to 20 percent ethanol. Currently, however, ethanol blends are only available in four Chinese provinces. Within these provinces all gasoline is blended with ethanol but ethanol is not available anywhere else in China. Besides concerns of availability, there is no limitation on the use ethanol blends. According to commission officials' estimations, as much as 25 to 30 percent of all cars in China will use corn-based fuel blends within two to three years (APEC 2001).

Since ethanol use is still in an experimental stage, domestic automobile production is not investing in technologies to enable cars to run on only ethanol at this point. Introduction of flex fuel cars which can run on either ethanol or gasoline would require introduction of technologies that are not currently available in China. The leaders

in the flex fuel market, Volkswagen and General Motors, have no plans to sell this type of vehicle in China at this point.

Ethanol Production in China

China initiated its ethanol push in 2001, outlining trial production in the Tenth Five-Year Plan (2001-2005) (Development Gateway). Since 2002, the country has promoted ethanol blends on a pilot basis in five cities in the central and northeastern regions: Zhengzhou, Luoyang and Nanyang (in Henan province) and Harbin and Zhaodong (in Heilongjiang province). The trial was further extended to nine provinces in 2004. Since October 2004, all gas stations in Jilin, Liaoning, Heilongjiang and Henan provinces, and selected areas in five other provinces, have implemented mandatory orders to provide only ethanol blended gasoline to all road vehicles, no matter who owns or uses the cars. Ethanol makes up 10 percent of the cleaner-burning fuel mixture in terms of volume. In 2005, China consumed about 12 million tons ethanol blended gasoline, accounting for roughly one fourth of gasoline consumption of China.

The Renewable Energy Act that entered into force in January 2006 listed ethanol as a priority for national energy development. In order to encourage the development of ethanol fuel, the Chinese government adopted the following four incentives for ethanol fuel manufacture. First, consumption taxes for alcoholic production are waived. Second, the state disburses value added taxes to manufacturers. Third, manufacturers are subsidized for using stockpiled state grains. Finally, the state subsidizes manufacturers for their losses in producing and transporting ethanol fuel. So far, only four state-owned

manufacturers chosen by the central government are eligible for these benefits because the central government can monitor their actual costs and revenues.

Due to these efforts, China has become the third largest ethanol producer after Brazil and the United States, generating 3.7 billion liters of ethanol in 2004. However, the country's heavy reliance on grains, particularly corn and wheat, for ethanol production has severely affected the future of the fuel in China. Scholars and officials began to argue that the ethanol plans would jeopardize food security in this populous country of 1.3 billion.

After five years of experimentation, the major challenge for development of ethanol is the concern for food security. China's grain production fluctuates from time to time. The need to use up stale stockpiled grain and to add value to agricultural commodities was initially a major driver behind China's ethanol endeavor. Just five years ago, wheat and corn surpluses were growing steadily, with annual grain production reaching 500 million tons. In 2002, the grain stockpile in Henan province totaled 35 million tons. In Jilin province, warehouses bulged with stocks after several years of good corn crops, leading prices to plunge to 25 year lows. After years of ethanol expansion, most stockpiled stale grain has been used up.

Robust economic growth means that China's demand for grain will continue to increase. Meanwhile, industrialization is quickly eroding agrarian production. More and more farmers are leaving rural areas to work in cities. As a result, China's grain production decreased from 1997 to 2003. This trend sent a strong alert to Chinese leaders. China became a grain importer again in 2004 after years of self sufficiency. Since 2004, a

number of policies have been implemented to raise farmers' incomes and stabilize grain production.

A number of scholars question the sustainability of an ethanol fuel strategy based on grains. Given the rapid growth in oil consumption, if the ethanol fuel policy is a priority strategy, the demand for grain will far exceed Chinese production abilities. Since China will have to import a lot of grain to meet domestic demands, they argued, the expansion of ethanol fuel plans will enhance China's reliance on foreign resources and inevitably exacerbate the national food security. In August, the Jilin Tianhe Ethanol Distillery, the world's largest, began purchasing new corn from granaries to meet its ethanol production needs and Tianguan Distillery in Henan has set up a 32,000 acre cassava production base in Laos.

The second major constraint for ethanol expansion is price. So far, the cost of ethanol fuel is well above the price of oil because ethanol is primarily produced from corn. Currently, the best resource for ethanol is sugarcane. However, China's production of sugarcane, is limited to 2-3 southwestern provinces and there is little additional land suitable for its cultivation. Rising sugar consumption, prompted by China's rapidly growing food-processing industry, has also made sugarcane-based ethanol commercially unviable. Additionally, the world sugar price has risen very steadily in recent years making this option more difficult. Research is being conducted into the viability of other crops such as sweet potato for ethanol production, but at this point corn remains the main source of ethanol in China (Jiang 2006).

The third argument opposing ethanol fuel is that ethanol manufacturers tend to be heavily dependent on subsidies from the government. The Chinese government has not

yet released formal data about how large subsidies to ethanol producers have been. However, due to high production costs, producers currently rely on public funding. Critics say that these manufacturers have become a fiscal burden to the state.

Lessons Learned from Brazil and the United States

Overview

Brazil and the US are the world leaders in ethanol production accounting for 80 percent of global ethanol demand (ESMAP 2005). Brazil is the world's largest producer and exporter of sugar and is also the world's largest producer and consumer of fuel ethanol. The country has been producing ethanol since 1931 though until 1975 it was mainly seen as a way to absorb excess molasses production. As demand for gasoline grew during the 1970s, Brazilian oil production was only sufficient to provide 70 percent of the fuel demanded. The government saw ethanol as a way to save hard currency by reducing the need for oil imports (Embassy of Brazil in India 2006). Between 1976 and 2004, Brazil is estimated to have saved \$60.74 billion in oil imports. When interest on avoided foreign debt is included this figure rises to \$121.26 billion. This is a significant figure considering that Brazil's foreign currency reserves were \$53.6 billion in January 2005 (Nastari 2005).

In sugar economies, 15-29 percent of sugar produced is sold as molasses at lower prices. Ethanol allows sugar producers to receive the higher price for all sugar produced (Nastari 2005). As the producer of one quarter of the world's sugarcane and home to the region with the world's lowest production costs for sugarcane, Brazil has a major

advantage in ethanol production. It has been the only country able to produce a renewable fuel for transportation that is cost-competitive with petroleum (ESMAP 2005).

An effort was made in Brazil to explore cassava-based ethanol production. However, the lack of a byproduct similar to bagasse that is a natural feedstock for ethanol production, difficulties with pests in large-scale cultivation and the labor intensive nature of cassava production have prevented commercial production of cassava-based ethanol (Nastari 2005).

In the US, ethanol is seen as a way to replace the toxic gasoline additive MTBE while helping America's farmers. Here, 90 percent of ethanol is produced from corn. The US is the world's largest producer and exporter of corn so there is an abundant supply of feedstock for ethanol production. Ethanol consumption in the US rose rapidly during the past two decades from 660 million liters in 1980 to 2.9 billion liters in 1990 and 5.6 billion liters in 2000 (ESMAP 2005).

Countries such as Brazil with ideal conditions for sugarcane production have a major advantage in ethanol production. The ratio of energy output to raw material input is 8.3 for sugar cane under Brazilian production conditions while it is only 1.9 for sugar beet, 1.3-1.8 for corn and 1.2 for wheat. This is the main reason behind the cost of ethanol being \$0.68 per gallon in Brazil, and \$1.05 to 1.20 per gallon from other sources of biomass in other countries (Nastari 2005).

In addition to the US and Brazil, the European Union, Australia, Colombia, India and Thailand have begun implementing national biofuels programs in recent years. As in the US and Brazil, mandatory blends and tax incentives have been the most successful tools used to promote ethanol production in these countries. Lessons learned from the

application and evolution of these standards and subsidies can be of great use to China as it seeks to refine its policies and expand ethanol production.

Mandatory Blends

Brazil

Blending of 5 percent anhydrous ethanol in gasoline was first mandated in Brazil in 1938 and has been adjusted several times since then. The percentage of the mixture of ethanol with gasoline is fixed today at 24 percent since motors and auto parts only have to be specially adapted if the ethanol content is above 30 percent (Embassy of Brazil in India).

The government also made ethanol-fueled vehicles mandatory in its official fleet when it launched its National Program of Fuel Alcohol in 1975. While this requirement was lifted during the 1980s, it was again reinstated in 1997 for vehicles in the federal government as well as those sold with tax exemptions such as taxis (ESMAP 2005).

United States

The 1990 Clean Air Act Amendments in the US mandated use of oxygenated fuels in non-attainment areas for federal air quality standards. There are two main options for meeting the oxygenated fuel requirement, MTBE and ethanol. While MTBE is cheaper, it has been associated with groundwater contamination and as of August 2005, 25 states had banned its use in gasoline. There has also been significant support for a federal ban of MTBE. This would provide significant opportunities for expansion of the ethanol industry.

The 2005 Energy Bill contained a Renewable Fuels Standard requiring that 7.5 billion gallons of renewable fuels be used annually by 2012. Every liter of ethanol produced from non-grain sources such as cellulose or waste counts as 2.5 grain-based ethanol towards this requirement. The bill also eliminated the oxygenated fuels mandate. It is expected that this will result in the ethanol content of gasoline rising until 2012 when it will gradually be replaced by cellulosic bioethanol which receives extra credit (US EIA).

Tax Breaks and Subsidies

Brazil

In the 1970s, the Brazilian government offered incentives for construction of ethanol distilleries which covered as much as 75 percent of construction costs. This led to rapid expansion of sugarcane production especially in São Paulo state. With the second oil crisis of 1979, the government created subsidies to stimulate the production and purchase of hydrated alcohol run cars. A goal of the subsidy program was to keep the price of ethanol below 65 percent of the price of gasoline (ESMAP 2005). This was a major driver in the spread of ethanol fuel in Brazil. This program was highly successful at the outset. In 1985, 96 percent of the cars produced in Brazil ran exclusively on hydrated alcohol. Since 1986 the percentage of cars running exclusively on hydrated alcohol has decreased due to the drop in international oil prices and the need to curb hyperinflation by reducing governmental expenditures and subsidies (Embassy of Brazil in India 2006). However, the use of ethanol/gasoline mixes has grown rapidly. Even without subsidies, there are still 4 million cars in the country that run exclusively on hydrated alcohol and

15 million that run on the mixture. Every gas station in Brazil has pumps for both hydrated alcohol and ethanol/gasoline mixes. The Brazilian government sets the price difference between gasoline mixed with ethanol and hydrated alcohol (30 percent less for hydrated alcohol) (Embassy of Brazil in India 2006).

United States

The Energy Tax Act of 1978 included a 40 cent per gallon federal excise tax exemption for ethanol in gasohol blends of at least 10 percent. This reduced the cost of ethanol to about the wholesale cost of gasoline. This tax exemption was soon supplanted by state tax incentives to fuel producers. By 1980, 25 states had exempted ethanol from at least part of their excise taxes. In 1980, Congress enacted a series of tax benefits to ethanol producers and blenders, including insured loans for small producers, an import tariff on foreign-produced ethanol and extension of the ethanol-gasoline blend tax credit. Production increased dramatically immediately after these incentives were introduced rising from 10 million gallons in 1979 to 175 million gallons in 1980 (US GAO 2000).

After the oil crisis of the 1970s, the oil price decreased for several decades. Average ethanol price was about twice that of gasoline. Therefore, financial incentives were very important in expanding the use of ethanol fuels. The ethanol industry has relied heavily on federal and state tax incentives to stay economically viable. In fiscal 2000, the partial exemption from the excise tax amounted to \$800 million and income tax credits for ethanol \$15 million (US GAO 2000).

In addition to incentives specifically for ethanol, corn producers receive the largest agricultural subsidies in the US. Large agro-businesses which are also involved in

ethanol production benefit greatly from these subsidies. The US Department of Agriculture also provides incentive payments to producers of ethanol and other biofuels. (US GAO 2000).

Recommendations

The experiences of Brazil and the United States provide several lessons for the development of ethanol fuels in China. First, national regulations guarantee a legal environment that promotes increased use of ethanol. As the market develops, standards can be gradually raised. Second, financial incentives have served to reduce the price of ethanol strengthen comparative advantages of ethanol.

1. The state should enact a national requirement for ethanol blended fuel. This type of standard has been key in the US and Brazil. So far, only nine provinces have joined the ethanol program. Given the high growth rate of oil demand and severe air quality problems in China, it is time to apply this program to the whole country. When the environmental and health benefits of ethanol/gasoline blends are taken into consideration, the cost of ethanol programs may look much more favorable.
2. Mandating ethanol use in government fleets is one way that China could increase the size of the market and demonstrate its commitment to ethanol. This measure has worked well in Brazil.
3. Subsidies and tax incentives have proven effective in increasing ethanol production in Brazil and the United States and are likewise viable options for China. While they were key to developing the market during the 1980s and 90s when oil prices were low, as oil prices continue to soar, the price gap between oil and ethanol fuel will

continue to narrow and government subsidies will be able to be decreased and ethanol fuel will become more and more attractive for consumers. In addition, subsidies can offer policy choices for government to increase household income in rural areas.

WTO rules restrict the Chinese government from subsidizing agriculture sector.

Subsidizing ethanol fuel production will transfer benefits to farmers. Therefore, this program could help raise rural living standards as well as improve air quality and reduce oil imports.

4. The state should open ethanol benefits to all producers so that not only the four specific manufacturers can benefit from incentives. Any ethanol producers are able to provide ethanol for fuel blends. This policy will spur competition among ethanol manufacturers and reduce costs.

Conclusion

While there has been significant criticism of Chinese efforts to promote ethanol fuel, these experiments are important for exploring options for China in the face of a huge and growing demand for oil, rocketing oil prices and major public health impacts from poor air quality. Considering it from a comprehensive perspective and balancing different aspects of national interests, we strongly recommend advancing the use of ethanol fuels in China.

There is no conflict between food security and ethanol fuel. China will inevitably become a food importer in the future, because it will gradually lose its comparative advantage in agriculture as it continues to rapidly develop. Moreover, after China joined the WTO, China has faced more pressure from developed and developing countries to

open its food market to other countries. Food security does not mean China should produce all necessary grains within its territory. Many factors have resulted in the decrease in Chinese grain production. Ethanol has been only a small part of this trend. The state agricultural policy can encourage grain production by providing incentives for farmers. The volume of grain production recovered after the government adjusted policies over the last two years.

Oil security, not food security, will be most important for Chinese development in the future. World oil reserves are not expected to increase dramatically. In fact, it is expected that peak production will be reached within the next several decades after which oil production will begin to shrink and prices will rise rapidly. Since China will need to increase its energy supply as the economy continues to grow and transportation demand continues to rise, it is crucial that China diversify its energy supply for transportation from oil to other energy sources.

In the meantime, we recommend that China implement policies that will encourage exploration of new fuel sources and methods for ethanol production. Technologies utilizing cellulose materials such as straw and corn stalks, which have no impacts on food supply and less land requirements, will be available in the near future. These agricultural wastes could be used productively in ethanol production. Currently, the second generation technologies to extract ethanol used in China are expensive and inefficient. China is researching options for producing ethanol from other resources, such as cassava or sweet potatoes. While cassava production was not successful in Brazil, conditions in China may be better for this crop. They have much higher production per acre and cassava can be planted widely throughout China. China produces 700 million

tons of straw and corn stalks that can be converted into 70 million tons of ethanol. As soon as the third generation technologies mature, domestic ethanol production will be much more feasible economically and will be less of a threat to food supplies.

The government should continue research into cassava, sweet potato and other alternatives to corn-based ethanol. As demonstrated by Brazil, the key to a successful ethanol program is finding a price-competitive source of production. As China does not have ideal conditions for sugarcane production, it must identify a cheap means of mass production of an alternative source with as high an energy content as possible. The government should provide more funding for research into the next generation of ethanol production technologies that will allow for cheaper production of ethanol from agricultural residue. These new technologies would result in a win-win situation where agricultural waste is converted into useful fuel with major environmental and national security benefits.

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