APEC BIOFUELS EXPERIENCES AND PRIORITIES

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ABSTRACT

APEC leaders and ministers have strongly supported the development of alternative transport fuels, including biofuels. As a group, APEC members produce about one half of the world's ethanol. The United States, China, Thailand, and Canada all have aggressive plans to increase the use of fuel ethanol in the near future. Once these plans are realized, APEC economies will together be leading the world in the production and use of biofuels.

INTRODUCTION

A priority for the development of alternative transport fuels in the APEC region has been set by APEC Economic Leaders and Ministers. APEC Economic Leaders, at their meeting in Brunei-Darusalam in November 2000, acknowledged the risks to the global economy posed by volatility in the international oil market and have called for appropriate measures to promote stability. In response to its mandate to address energy issues of concern to the APEC Economic Leaders, the APEC Energy Working Group (EWG) initiated the *Energy Security Initiative* in September 2001. Both short- and long- term options have been formed as part of a strategic approach to energy security in the APEC region. As one of the long-term policy approaches to support the Energy Security Initiative, the Expert Group on New and Renewable Energy Technologies (EGNRET) was asked to "explore alternative fuel sources and measures to conserve and use energy more efficiently and to safeguard the environment". In June 2004 in the Philippines, the APEC Energy Ministers had their sixth meeting under the theme *Energy Security in APEC: Cooperation for a Sustainable Future*. At this meeting, the Energy Ministers called "for accelerated cooperation on the development of alternative transportation fuels." At their 23rd meeting held in New Zealand in November of 2004, the EGNRET agreed to establish a collaborative working area on alternative transport fuels as part of the APEC 21st Century Renewable Energy Development Initiative. Collaborative IX: Alternative Transport Fuels, is being led by New Zealand, with the assistance of the US.

APEC already leads the world in biofuels production. Virtually all APEC economies have expressed interest in the utilization of either ethanol or biodiesel. Currently, ten APEC economies have significant production of ethanol. The 2004 production of ethanol, used mostly for gasoline blending, is shown in Table 1 below. As can be seen, two of the top three ethanol producers in the world are APEC economies and together, APEC economies produce just about one half of the world's ethanol. For comparative purposes, the production from Brazil, currently the largest producer of ethanol in the world, is shown.

Table 1: APEC Ethanol Production in 2004
(million US gallons)

United States	3,530
China	964
Thailand	74
Canada	61
Indonesia	44
Japan	31
Australia	33
South Korea	22
Philippines	22
Mexico	9
Total APEC	**4,790**
World total	**10,777**
Brazil	3,989

Source: Renewable Energy Fuels Association (www.ethanolrfa.org)

In addition, several APEC economies have announced plans to significantly increase their ethanol and biodiesel production. The recently passed US national energy legislation calls on the US to increase its ethanol utilization in gasoline blends from 4,000 million gallon/year in 2006 to 8,000 million gallons in 2012. Large increases are also being planned by Canada, China and Thailand. As part of its climate change program, Canada has set a target of 35 percent of its gasoline to contain 10 percent ethanol by 2010. This would bring the current Canadian production from 61 million gallons to about 350 million gallons per year. Thailand has likewise set an aggressive goal of blending all of its gasoline with 10 percent ethanol by 2009. This would bring Thailand's ethanol production to about 396 million gallons per year. Plans of selected APEC economies are briefly discussed in more detail below.

China

Mr. Ma Hongjian, Deputy Director of the China National Center for Biotechnology Development, stated that "Developing biofuels results from the shortage of energy resources". In February 2004, the Chinese government ordered five provinces to include 10 percent ethanol in their gasoline. Together, these provinces account for about 16 percent of China's passenger vehicles. Ethanol blends are expected to be extended to at least 27 other cities by the end of 2005.

China is also home to the largest distillery in the world. The Jilin Tianhe Ethanol Distillery is currently producing 240 million gallons per year, and has a potential capacity of 320 million gallons per year. The current feedstocks for Chinese ethanol production include corn, wheat, cassava, and molasses. The promotion of biofuels is part of China's policy to increase renewable energy use to about 15 percent of total supply by 2020, up from about 7 percent today.

Thailand

The Thai government has been implementing policies to promote the use of alternative fuels to reduce oil consumption. One of which is to accelerate the production of ethanol from sugarcane. Thailand is the world's second largest sugar exporter after Brazil. The country is a large producer of molasses, cassava and other forms of biomass. Thailand has more than 90,000 sugarcane growers and a sugar growing area of around 1.1 million hectares.

The Thai government fully supports ethanol production, as Thailand has abundant raw materials. The abundance of ethanol feedstocks should be particularly advantageous to the country, when compared with other nations in the region. Thailand produces a great volume of sugarcane and tapioca, but the export value of these products is relatively low. If the country produced ethanol from the sugar destined for export, it could produce 2 million gallons of ethanol a day. Ethanol produced from tapioca pellets destined for export would reach around 1.3 to 1.6 million gallons a day.

The Ministry of Industry has recently granted licenses to 18 ethanol producers. Together with 6 existing operators, the number of ethanol plant operators in Thailand has increased to 24, with a production capacity of 1 million gallons a day. The Government has set a target to produce at least 3 million liters (0.8 million gallons) of ethanol a day by 2008. By law, the 18 new ethanol operators must acquire plots of land and machinery for ethanol plants within three months. They are required to build the plants within two years. The Ministry of Industry gave its assurance that the private companies seeking to establish ethanol plants would be able to market their ethanol. There are currently 233 gasohol service stations both in Bangkok and in nearby provinces, which help accommodate ethanol consumption.

There is a strong possibility that Thailand would become an ethanol production center in the region. Ethanol consumption in the region is likely to grow significantly. China, India, Japan, and South Korea are in need of large volumes of ethanol. Japan, in particular, consumes around 79 to 105 million gallons of ethanol a year. Japan plans to increase the ethanol import volume to 158 million gallons annually in the next five years.

United States

In the US, the biofuels are being aggressively supported by both the national government and state governments. As mentioned earlier, the recently passed Energy Policy Act of 2005 seeks to double the amount of ethanol used by 2012. Major factors driving the development of biofuels in the US are energy security, environmental protection, and the benefits to regional economic development. The US also supports a strong research program in both biofuels production and vehicle development. An example of activities being undertaken at the state level are the recent actions of Minnesota, which is requiring the use of E20 (20 percent ethanol blend), by 2010 and has a goal of reducing the states gasoline consumption by 50 percent by 2015. At the private sector level, General Motors (GM) recently announced that they will successfully reduced the cost of

manufacturing vehicles that can run on any gasoline/ethanol mix (known as flexible fueled vehicles--FFV). GM plans to be producing and selling FFV in 2006 at minimal additional cost over conventional vehicles. This technical advance significantly reduces what was seen as a critical barrier to the widespread adoption of high (greater than 10 percent) blends of ethanol based fuels.

Biofuel Economics

The utilization of biofuels requires not only the production of the fuel itself, but the development of an infrastructure to deliver and utilize the fuel. With the high current price of oil, the production of ethanol from grains or sugarcane can be cost effective with gasoline production.

The largest component of overall production costs of biofuel is cost of feedstock. The agricultural subsidy program by a government will have significant impact on feedstock prices and thus production costs of biofuels. The technologies involved in ethanol production are quite mature. While incremental cost reduction can be expected (i.e., through technical improvements and optimization), no major breakthroughs are anticipated that could bring costs down dramatically. The greatest potential cost reductions lie in continued development of advanced technologies to convert biomass (cellulosic) feedstock to ethanol and eventually, to hydrogen and to other liquid fuels like synthetic diesel. A number of recent studies suggest that the cost of producing cellulosic ethanol could fall below the cost of producing grain ethanol in the 2010-2020 timeframe.

Brazil is the lowest-cost ethanol producer because of low feedstock costs. The European Union's ethanol production cost is high because of high feedstock costs (due to various forms of agricultural subsidies) and also because the production plants are relatively small and thus not optimized. The US has higher input costs but has efficient plants. US production cost is in between that Europe and Brazil.

Feedstock cost is about half of total production cost, operating cost is about one-third, and capital cost is about one-sixth. An analysis by Whims (2002) shows that plant size has a major effect on cost. Whims estimates that for both dry-mill and wet-mill operations in the US, about a tripling of plant size (from 55 to 150 million liters per year for dry mill plants and 110 to 375 million liters per year for wet-mill plants) results in a reduction in capital costs of about 40 percent per unit of capacity, saving about $0.03 per liter, and reduction in operating costs by 15 percent to 20 percent saving another $0.02 to $0.03 per liters. Thus a large plant with production costs of $0.29 per liter may be saving $0.05 to $0.06 per liter over a smaller plant. Fuel ethanol "gate" prices in the US have averaged about $0.30 per liter ($1.14 per gallon) over the past twelve years.

Table 2: Comparison of ethanol production costs (US$ per liter)

	Europe[2]		US[1]	Brazil[4]
	Sugar beet	Wheat	Corn	Sugar cane
Net feedstock cost	$0.20-0.31	$0.11-0.19	$0.13	$0.127
-Feedstock cost	$0.20-0.32	$0.22-0.34	$0.23	
-Co-product credit	($0.00-0.01)	($0.11-0.15)	($0.11)	
Operating cost		$0.20-0.25	$0.11	$0.014
-Labour/admin/ maintenance			$0.05	$0.010
-Chemical cost			$0.03	$0.002
-Energy cost			$0.04	$0.002
Capital recovery		$0.08-0.13	$0.05	$0.062
Other	$0.22-0.28[3]			$0.026
Total cost/liter (gate price)	$0.42-0.60	$0.35-0.62	$0.29	$0.23
Cost per gasoline-equivalent liter	$0.63-0.90	$0.53-0.93	$0.43	$0.34
Cost per gasoline-equivalent gallon	$2.39-3.42	$2.01-3.53	$1.63	$1.29

[1] IEA, 2004, Table 4.1, p 69, in 2000 US $ per liter
[2] IEA, 2004, Table 4.2, p 71, in 2000 US $ per liter
[3] "other" includes all non-feedstock costs.
[4] IEA, 2004, Table 4.4, p. 75, average cost in 1990 US $ per liter

Ethanol production costs in Brazil have declined since 1990 because of substantial efficiency improvements in the cane production and ethanol conversion processes and more widespread adoption of electricity cogeneration using excess cane (bagasse). Recent production costs in Brazil for hydrous ethanol are as low as R$0.45 per liter or about US $0.15 per liter (at the exchange rate in Jan 2004), or US$0.23 per gasoline equivalent liter (or US$0.87 per gasoline equivalent gallon).

Biofuel Transportation Costs

Biodiesel is much easier to transport than ethanol because it can use the same transportation and storage infrastructure as conventional diesel. Similarly, equipment that is used to store, transport and deliver diesel can also be used for biodiesel with no modification, whereas minor modifications and some degree of fuel separation is needed for ethanol. Because ethanol is an alcohol, it creates some compatibility problems with the existing infrastructure.

- The ethanol at the production facility will be denatured.
- The blend has to be shipped to a storage terminal until sufficient supplies have been collected for redistribution on to fuelling station.
- Final blending with gasoline typically occurs at the storage terminal. To blend ethanol, an existing terminal must have a tank of sufficient size. Blending system must be installed (or existing blending systems modified) to accommodate gasoline-ethanol blending. "Splash blending" is sometimes used, where ethanol is mixed with gasoline as the gasoline delivery truck is loaded in preparation for delivery to fuelling stations.
- Blended ethanol will be sent to fuelling stations.

Gasoline refueling pumps can easily be adjusted to accommodate ethanol, either as a blend with gasoline or as pure ethanol. Low percentage ethanol blend such as E10 does not need any modification and has few reported problems. Higher blends i.e., E85 have a tendency to degrade some materials, and they require minor modifications or replacement of soft metals such as zinc, brass, lead and aluminium. Non-metallic materials (i.e., natural rubber, polyurethane, cork gasket material, leather, polyvinyl chloride (PVC), polymides, methyl-methacrylate plastics, etc.) also degrade when in contact with fuel ethanol over time. If these materials are present, refueling station storage and dispensing equipment may need to be upgraded or replaced with ethanol-compatible materials such as unplated steel, stainless steel, black iron and bronze. Also, the tank (or liner) must be compatible with gasoline-ethanol blends and any water-encroachment problems must be eliminated.

Overall the total cost of transporting, storing, and dispensing ethanol in the US ranges from $0.012 to 0.072. New E85 retail station infrastructure is more expensive, possibly adding another $0.02 per liter of ethanol. Ethanol fuel markets are normally close to feedstock areas and production facilities because of transportation costs.

Conclusions

Biofuels are being recognized as an important alternative to petroleum based fuels by APEC leaders and energy ministers. Several APEC economies are aggressively pursuing the expansion of biofuels as part of national energy planning priorities. Currently, APEC member economies are the second and third largest ethanol producers in the world, and together APEC economies produce just about one half of the world's ethanol. APEC member economies have aggressive biofuel policies in place that will more than double the current ethanol production by the year 2012.

APEC member economies have developed a range of policies that support and promote the utilization of biofuels. APEC member economies are also leading the world in developing new technologies for both the production of biofuels (such as cellulosic ethanol production) as well as new technologies on the end use side that significantly reduce the cost of utilizing biofuels. It is important that the experiences and lessons learned from current biofuel programs be shared among APEC members. These lessons cover both the policies and technologies necessary to successfully utilize cost effective biomass based transport fuels as part of an economy's fuel mix. Although the costs of producing biofuels are decreasing and currently competitive with petroleum based fuels, the infrastructure required to effectively utilize biofuels needs to be addressed in most APEC economies.

Acknowledgments

This work was supported by the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, under contract W-31-109-Eng-38. The views expressed are those of the author alone and should not be construed as representing the official positions of Argonne National Laboratory, or the U.S. Department of Energy.

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