Global Biofuels Picture and the Prospects for International Trade

Sergio C. Trindade
strindade@internationalfuel.com

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Sugar and Ethanol: Raw Materials and Markets

Veg. Oils and Biodiesel: Raw Materials and Markets

Biofuel Yields: Ethanol and Biodiesel Feedstocks

The New York Times
May 1, 2006
EDITORIAL
Ethanol’s Promise

The political scramble to find quick answers to rising oil prices has produced one useful result, which is to get people talking about substitute fuels that could make us less vulnerable to market forces, less dependent on volatile Persian Gulf oil producers and less culpable on global warming.
World Ethanol 2005
production by country


% share of fuel ethanol of the gasoline market globally

Brazil
Peru
USA
Canada
Colombia
Venezuela
Australia
Central America
India
Philippines
Thailand
China

World Ethanol Production
Fiscal 2005

Shares of USA and Other are likely to increase at the expense of Brazil in the short term, but overall output is expected to increase everywhere


World Ethanol 2007
Fuel ethanol's increasing global appeal

• Sugar dampens Brazil's ethanol growth
• USA phases out MTBE, ethanol wins
• EU starts investment drive
• Asia/Pacific confirms ambitious targets
• Africa – the next success story?

Biodiesel: comparison with vegetable oil prices

• Soybean oil
  – $500/ton = $0.46 per liter
• Palm oil
  – $400/ton = $0.37 per liter
• Coconut oil
  – $560/ton = $0.52 per liter
• Add $0.10-$0.15 per liter for converting vegetable oil into biodiesel

Land Area and Yield Trends of Biodiesel Crops Over the Last Decade

World Biodiesel Production, 3.5 billion liters, 2005


Market Development of Biodiesel in Germany

Biodiesel World Production 1991-2005

Biodiesel Production Projections to 2020

This is the world we all live in!
Our common home!
Brazil Bioethanol Policy History

• Sugar cane based ethanol: displaces 40% gasoline + oil self-sufficiency (2006)
• State of São Paulo initially driving supply and demand
• Up to 1975: Ethanol blending when convenient

Brazil Bioethanol Policy History

• 1975: Proalcool
• 1980s: Neat ethanol introduced
• 1990s: Moderate oil prices, ethanol set backs, ethanol imports, removal of all incentives, except blend mandate
• 2000s: Ethanol competitive, expansion, exports, biodiesel, Brazilian FFVs, World trade promotion, NYBoT futures/options

Brazilian Sugar Cane Industry:
Key Stakeholders

Agriculture
Sugar and Ethanol Making
Fuel Distributors
Ethanol transportation, storage, distribution and end-use
Gasoline Retail Stations
Exports

Ethanol Production in Brazil

Necessary Modifications

(Otto Engines)
The Scale Factor: Brazil Ethanol Learning Curve

Source: Adapted from Goldemberg, et allii, Ethanol learning curve – The Brazilian experience, Biomass and Bioenergy 26 (2004) 301-304

Policy Lessons

- Consensus among the key stakeholders: oil industry, auto industry and ethanol/sugar makers
- Cooperation between cane growers and mill/distillery owners
- National innovation system in place
- Agricultural research, extension, and application by farmers: critical for lowering production costs

Area utilization (%) for the most planted sugar cane varieties in Brazil, 1984 - 2003


Policy Lessons

- Comprehensive utilization: surplus bagasse, cogeneration
- Waste reduction in harvest (stopping field burning of tops and leaves) and ethanol production (proper stillage disposal)
- Supportive government policies

⇒ Replication of Brazil’s ethanol experience requires assessing risks and the factors necessary for success over the long term

Asia/Pacific – Gasoline markets (million m³)

Growth rates vary widely among countries: Vietnam (15.6 %), Thailand (13.1 %), Taiwan (11.9 %), S. Korea (11.1 %), Philippines (2.9 %), Malaysia (4.4 %), Japan (1.2 %), Indonesia (3.1 %), India (10.7 %), China (9.8 %) and Australia (3.6 %)

REST OF THE WORLD
Bioethanol for domestic consumption in key developing countries

- China: 20% of gasoline consumed contained ethanol in 2005
- Colombia, Peru: 10% ethanol in gasoline targeted
- Paraguay: 7%. Plans for Mexico, South/Central America, Caribbean
- India: 5% ethanol in certain states

Biofuels for domestic consumption in key developing countries

- Indonesia: 3% of energy from plant-based fuels by 2025
- Malaysia: biodiesel from palm oil, trial underway
- Philippines: biofuels legislation signed in January 2007
- Thailand: explosive growth of E10

Positive factors – Asia/Pacific

- India’s fuel ethanol programme restarted?
- Thailand’s improved sugar cane crop will boost ethanol
- Philippines to start production
- China and Australia to exceed expectations?

Europe – Gasoline markets (million m³)

Growth rates vary widely among countries: Other EU (-0.2 %), UK (-1.2 %), Spain (-3.2 %), Italy (-3.7 %), Germany (-2.7 %) and France (-3.0 %)

US Bioethanol Policy History

- Corn-based ethanol: displaces 3% gas (2006)
  30% of 2004 demand DOE target for 2030
- California, East Coast driving demand, Midwest supply, States’ programs and mandates
US Bioethanol Policy History

- **1980s**: Gasohol stretching gasoline, octane, fiscal incentives, imports, import barriers
- **1990s**: Moderate oil prices, Reformulated gasoline oxygen, Winter gasoline, MTBE and ethanol, stretching gasoline, octane
- **2000s**: MTBE ban, ethanol expansion, 2005 Energy Bill, biofuels mandates, biodiesel, US FFVs E-85 program, Chicago exchanges corn ethanol contracts

USA – success brings new problems

- Will decreasing farmer involvement erode support in Washington?
- What if Wall Street loses interest?
- Food and animal feed industries fear higher prices for corn

Biofuels Reality: Fuel Ethanol Costs and Prices of Gasoline, 2004

<table>
<thead>
<tr>
<th></th>
<th>Ethanol (with tax)</th>
<th>Gasoline (w/o tax)</th>
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</thead>
<tbody>
<tr>
<td>United States</td>
<td>0.36 (corn)</td>
<td>0.45</td>
</tr>
<tr>
<td>Euro Union</td>
<td>0.70 (wheat)</td>
<td>1.09</td>
</tr>
<tr>
<td>Brazil</td>
<td>0.27 (sugar cane)</td>
<td>0.69</td>
</tr>
</tbody>
</table>

Biofuels Reality: Biodiesel Costs and Prices of Diesel, 2004

<table>
<thead>
<tr>
<th></th>
<th>Biodiesel (with tax)</th>
<th>Diesel (w/o tax)</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>0.50 (soy)</td>
<td>0.47</td>
</tr>
<tr>
<td>Euro Union</td>
<td>0.56 (rape)</td>
<td>1.06</td>
</tr>
<tr>
<td>Brazil</td>
<td>0.52 (soy)</td>
<td>0.40</td>
</tr>
</tbody>
</table>

Note: Bioethanol prices are adjusted for the difference in energy content per liter of ethanol (0.67 the energy of gasoline). Biofuel prices are adjusted for the difference in energy content per liter of biodiesel (0.9 the energy of diesel). Adapted from: Worldwatch Institute (2006). Biofuels for Transportation, Washington, DC, June.
Global carbon market and biofuels

Carbon credits won't make much difference (Assume 100% GHG offset, 20-80% likely)

- $5-10/t CO2-eq in short to medium term equivalent to $0.01-0.035 per liter of biofuel
- $15-20/t CO2-eq over the coming decade equivalent to $0.03-0.07 per liter of biofuel
- Compared to range of government support: $0.00 (Brazil) - $0.14 (US) - $0.79 (Germany) per liter for ethanol

Adapted from Kojima, Masami and Todd Johnson (2006). Potential for Biofuels for Transport in Developing Countries; Presentation at World Bank Energy Week, Washington, DC, 7 March.
Biofuels and Technologies

First Generation, Neat or Blended

- **Ethanol** – Commercial E10 - E85 from starch (grains) and sucrose (cane or beet). ETBE in Europe. Wood and straw cellulosic material resources (under development)

- **Biodiesel** – Commercial B2 - B5 and B20 as FAME (Fatty Acid Methyl Ester) from fats, grease, vegetable oils (Soy, Castor, Rape, Palm, Sunflower) blended with regular diesel

Source: Overend, Ralph and Helena Chum, 2006. Advancing the commercialization and deployment of renewable energy and energy efficiency technologies. Ethanol & Biofuels Asia 2006, Singapore, November 3rd

Biofuels and Technologies

Second Generation – under dev’t

- **Green Diesel/Gasoline** – renewable carbon from fats, grease, vegetable oil processed with crude oil or refinery fractions and hydrogen to produce low-sulfur diesel/gasoline in petroleum refinery

- **Butanol** - C4 alcohol from sugar (sugar, starch, cellulosic) fermentation

Source: Overend, Ralph and Helena Chum, 2006. Advancing the commercialization and deployment of renewable energy and energy efficiency technologies. Ethanol & Biofuels Asia 2006, Singapore, November 3rd

Biofuels innovation is a must!

- 5% Biodiesel replaces ~5% diesel

  New fatty acid based technology by IFT (www.internationalfuel.com)

  • 0.17% DiesoLIFT replaces 5% diesel !
  - 30 x more efficient than biodiesel !
  - Saves fossil (diesel) and renewable resources (biodiesel)


Biofuels trends

**Near term**

- Ethanol from sugarcane: best overall chance of commercial viability
- Biofuel trade liberalization beneficial to all consumers
- Biodiesel remains expensive relative to world oil prices

**Medium term**

- Fall in production costs
- New feedstocks, second generation technologies
- Growing trade

**Long term**

- Commercialization of cellulosic ethanol: widespread availability, abundance, and significant lifecycle GHG emission reduction potential
- Higher oil prices favoring biofuel economics

Adapted from Kojima, Masami and Todd Johnson (2006). Potential for Biofuels for Transport in Developing Countries; Presentation at World Bank Energy Week, Washington, DC, 7 March.

Fuel vs. food – self-sufficiency ratios

[Graph showing self-sufficiency ratios for different regions with oil: grain/sugar ratio indicated.]
Barriers to Biofuels Development

- Risk perception
- Venture capital availability
- Marketing approaches
- Lacking infrastructure
- Public policies, innovation system, the environment

Barriers to Biofuels Development

- Sustainable supply, well functioning market
- Definite limits to biofuels to meet transport fuels demand
- Wasteful mindsets pressure on fuel supplies, biofuels included
- Limited International trade

BIOFUELS GROWTH ISSUES: INTERNATIONAL TRADE, SUSTAINABILITY, FOOD VS FUEL

- Need for significant domestic markets
- International trade needed for sustainability
- Excessive protection to domestic producers
- Biofuels trade classification: greenbox or Subsidies & Coutervailing Measures (SCM)
- Incipient futures and options markets
- Sustainability certification of biofuels, but not for fossil fuels?
- Impact on the price of food
- Over time, need to disengage food/fuel
- Exporting country infrastructure limitations