The Future of Biofuel Development and Use

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Biofuels development and use depends on several key factors:

- Biofuel Economics (cost of ethanol vs. petrol and biodiesel vs. diesel)
- Biofuel Trade Opportunities (created by production cost differentials
- Biofuel Infrastructure (cost and time to build biofuel filling station network)
- Fuel-Flexible Vehicles (practical path of uptake into the automobile market)
- Biofuel Resources (current and potential availability of biofuel feedstocks)

Biofuel Economics and Trade

- Biofuels from a variety of feedstocks are cost effective at current oil prices, and the options are expanding.
- Major cost differentials for biofuels produced from different crops in different places mean significant opportunities for biofuels trade.
- Performance-based biofuel standards can encourage international trade.

Cost of Biofuel in Brazil

- Various studies indicate that Brazil can produce ethanol from sugarcane for an overall cost between $US0.20 per liter and US$0.30 per liter.
- This would make Brazilian ethanol competitive with gasoline at crude oil prices of $28 to $50 per barrel.

Cost of Biofuel in USA

- In the USA, we have learned that ethanol from corn can be produced for US$0.30-0.37 per liter, including:
  - 21 cents feedstock cost at $88 per ton (or 32 cents if corn costs 50% more),
  - 3 cents capital plant cost assuming 5% cost of capital and 20-year lifetime,
  - 12 cents operation and maintenance (O&M) and labor costs, and
  - 6 cent credit for Dried Distillers Grains and Solubles (DDGS) as co-product (or 10 cents if corn prices are 50% higher).
- Competes with crude at $50-68/barrel

Cost of Biofuel in Malaysia

- In Malaysia, we have learned that biodiesel from palm oil can be produced for about US$0.38 per liter:
  - 26 cents in feedstock cost,
  - 6 cents in capital plant cost, and
  - 6 cents for labor and O&M, with a
  - <0.5 cent credit for glycerine co-product.
- Competes with $42/barrel crude.
- Similar cost picture in Indonesia

Cost of Biofuel in Indonesia

- Indonesia can produce biodiesel from jatropha for around US$0.48 per liter:
  - 37 cents for feedstock
  - 7 cents for capital plant cost assuming 10% cost of capital,10-year plant life.
  - 4 cents in labor and operating costs
  - No credits for byproducts
- Competes with crude at $58/barrel
- Biodiesel from palm oil is cheaper.

Cost of Biofuel in Chinese Taipei

- In Chinese Taipei,biodiesel can be produced from waste cooking oil for about US$0.70 per liter, including:
  - US$0.48 feedstock cost at $753 per ton,
  - US$0.02 capital plant cost assuming 10% cost of capital and 10-year lifetime,
  - US$0.20 operation and maintenance (O&M) and labor costs, and
  - No credit for byproducts
- Crude might have to climb to $93 per barrel for this kind of biodiesel to compete.

Cost of Biofuel in Korea: Better Think About Biofuel Import Options

- In Korea, biodiesel can be produced from rapeseed for US$1.37 per liter, including:
  - US$1.58 feedstock cost at $753 per ton,
  - US$0.03 capital plant cost assuming 5% cost of capital and 20-year lifetime,
  - US$0.20 operation and maintenance (O&M) and labor costs, and
  - US$0.44 credit for glycerin, oil cake and straw co-products.
- Crude oil price would have to rise to $200/barrel for this to be cost-competitive.

Strategic Interest to ASEAN of Biofuels Trade in the Asia Pacific

- Biofuels can make more oil available for export from region (examples: Malaysia and perhaps Indonesia again)
- Trading partners can start to diversify transport sectors away from reliance on oil, reducing dependency on Middle East (Examples: Japan, Korea, Chinese Taipei)
- Very substantial resources are being devoted to biofuels development, with a very real economic and strategic potential at today's oil prices.

Notable Points on ASEAN Biodiesel

- Biodiesel from ASEAN palm and jatropha is much more economical and has much greater resource potential than “traditional” biodiesel from crops like soybeans and rapeseed in the US and Europe.
- Technical characteristics of biodiesel from palm are far from ideal for cold weather.
- Performance-based standards (allowing palm blends) are thus essential if trade is to evolve: prescriptive standards (prohibiting biodiesel with characteristics matching palm) would kill trade.

2007 APEC Project on Guidelines for Developing Biodiesel Standards

- By establishing guidelines for development of biodiesel standards, the project aims to enhance the potential for biodiesel trade among Asia Pacific economies.
- Project is being led by Thailand while Australia, Chinese Taipei, New Zealand and US are among the co-sponsors.
- Project was developed through APEC Expert Group on New and Renewable Energy Technologies, in cooperation with the APEC Biofuels Task Force.

The Challenge of Harmonizing Biodiesel Standards Internationally

- Biodiesel quality depends on the natural characteristics of feedstocks, which include a variety of animal fats and vegetable oils.
- EN 14214:2003 and ASTM D 6751:2003 are the standards currently used
- The feedstocks used in EU and US are different from those used in much of Asia.
- US and EU Standards Bodies should take Asian biodiesel into account to allow trade.

Long-Term Trends Will Expand Worldwide Biofuel Potential

- The gradual depletion of easily recoverable oil reserves is causing an upward trend in real, inflation-adjusted oil prices.
- Growing concerns over global warming may yield a clear market value for carbon.
- RD&D is rapidly bringing down the cost of abundant lignocellulosic feedstocks like farm and forest residues and grasses that have much lower carbon emissions than the current generation of biofuel crops.

Costs of Ethanol from n^{th} of a Kind Lignocellulosic Production Plant

- A US study indicates the cost of producing ethanol from corn stover could decline to about $0.24/ liter:
  - 9 cents feedstock cost at $30 per ton,
  - 9 cents capital plant cost assuming 10% cost of capital and 20-year lifetime,
  - 9 cents O&M and labor costs, and
  - 3 cent credit for electricity co-product.
- This would compete with $30 crude!

Abundant Lignocellulosic Resource

- A small but significant percentage of oil use could potentially be displaced by biofuels produced from conventional agricultural crops, dependinging on factors such as available land, crop yields, production costs, climate, and automobile use.
- A larger percentage of crude oil use could be displaced if biofuels were supplied as well from cellulosic feedstocks like crop residues, forest residues and new crops designed for biofuel production or grown on marginal or degraded land.

Biofuel Resources in ASEAN from Agricultural Residues

- Mitsubishi Research Institute Paper, Tokyo International Biofuels Conference 2007

Economy	Ethanol Million Liters	Ethanol Million Tons	Gasoline Million Tons
Indonesia	55,995	44.2	27.7
Malaysia	16,157	12.8	8.0
Philippines	21,617	17.1	10.7
Thailand	13,968	11.0	6.9
Viet Nam	11,138	8.8	5.5

Potential Oil Displacement from Biofuel Resources in APEC-ASEAN: Ethanol from Agricultural Residues as Share of Petroleum Demand

Ethanol Potential from Agricultural Residues as Share of

	Petroleum Demand		Transport Oil Demand	
Economy	2002	2030	2002	2030
Indonesia	59%	25%	117%	40%
Malaysia	40%	16%	60%	21%
Philippines	78%	28%	119%	36%
Thailand	22%	7%	37%	11%
Viet Nam	65%	12%	117%	21%

Additional Estimates of Ethanol Resource Potential Evaluated by the APEC Biofuels Task Force

Economy	Ethanol Million Liters	Ethanol Million Tons	Gasoline Million Tons
Australia	9,804	7.7	4.9
Canada	4,194	3.3	2.1
Thailand	54,831	43.3	27.2
USA	352,565	278.3	174.7

Potential Oil Displacement by Ethanol Resources in APEC: Ethanol from Various Sources as Percentage of Petroleum Demand

Ethanol Potential from Available Resources as Share of

	Petroleum Demand		Transport Oil Demand	
Economy	2002	2030	2002	2030
Australia	14%	9%	18%	11%
Canada	3%	2%	4%	3%
Thailand	87%	28%	145%	43%
USA	23%	16%	29%	19%

Example: Biofuel Resources Beyond Food Crops in Thailand

Summary of Biofuel Potential In Thailand by Type of Resource	Annual Harvest (million tons)	Fuel Yield (liters fuel per ton of feedstock)	Biofuel Production Potential (billion liters)
Agricultural Residues	53.7	300	16.1
Animal Waste	3.2	300	1.0
Wood Supplies	48.8	300	14.6
New Wood Plantations	59.2	300	17.8
Municipal Solid Waste	5.6	300	1.7
Biomass Saving	12.3	300	3.7
Total	182.8	300	54.8

Climate Change Benefits: Biofuels from Conventional Agriculture

- For ethanol produced from corn and sugar cane, energy output is substantially greater than fossil energy input, so that net life cycle carbon emissions are lower than for transport fuels derived from crude oil.
- Energy and carbon balances for biofuels from conventional crops should improve over time as sustainable crop yields increase and as processes for converting crops to biofuels become more efficient.
- Life cycle carbon emissions for biodiesel from palm depend on where the palm is planted and need to be better understood.

Climate Change Benefits: Biofuel from Farm and Forest Residues

- For biofuels produced from lignocellulosic feedstocks, positive energy balances and carbon-equivalent emissions reductions are several times greater than for biofuels made from food crops, so lignocellulosic feedstocks represent the greatest long-term opportunity for biofuels to contribute to energy and environmental security.
- Since a large share of potential biofuel resources are lignocellulosic, achievable reductions in crude oil dependency and greenhouse emissions may be substantial.

Biofuel Use Can Expand with Fuel-Flexible Vehicles and Infrastructure

- Existing vehicles and filling stations can accept up to 10 percent ethanol blends with gasoline (E10) or 5 percent blends of biodiesel with conventional diesel (B5) with little or no modification.
- New vehicles can be manufactured to be fuel-flexible between conventional petrol and blends of up to 85 percent ethanol (E85) at a very modest incremental cost.

Interest in Biofuels is Growing!

- *Thanks for listening!*
- *Your views are welcome!*