

Viability of Alternative Energy Sources; e.g. Ethanol and Other Biofuels and Their Potential Impacts on Food System

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OVERVIEW

- **Why biofuels?**
- **Feedstock used for production of biofuels**
- **Production process**
- **World biofuel production**
- **Economic effects of biofuel production**
- **Net energy balance of biofuels**
- **Conclusions**

Why Biofuels?

- **To increase energy security**
- **To create jobs and enhance the economic development of rural economy**
- **To enhance the environment and public health**
- **To diversify markets for agricultural and forestry products**

What are Production Process?

- **Biodiesel**-estrication, bioparaffins

- **Ethanol:**

Sugar platform--fermentation process

- starch and sugar
- Biomass materials

Thermo chemical process--

- Fischer & Tropsch (BTL)
- Pyrolysis (biocrude)

What are the Feedstocks?

- **Crops containing:**

- Starch- grains, roots, etc.

- Sugar- sugar beets, sugar cane, sweet sorghum, etc.

- Oil-soybeans, rapeseed, peanuts oil, Palm oil, coconut oil, jatropha, etc.

- Energy crops-fast growing grasses and trees

- **Byproducts-** molasses, cheese whey, etc.

- **Animal fats-** tallow, lard, etc.

- **Agriculture and forestry residues**

- **Organic wastes-**waste sugar and starch, sorted municipal solid waste, etc.

Biofuels Feedstock

- **Present:**
 - **Conventional**--Sugarcane, sugar beets, corn, sorghum, wheat, barley, Oilseeds, animal fats, cassava, molasses, whey, waste sugar and starch
 - **Non-conventional**– palm oil, coconut oil, jatropha, pongamia
- **Future:**
 - Sorted municipal soiled waste, manure, agriculture and forestry residues, food processing waste, dedicated energy crops

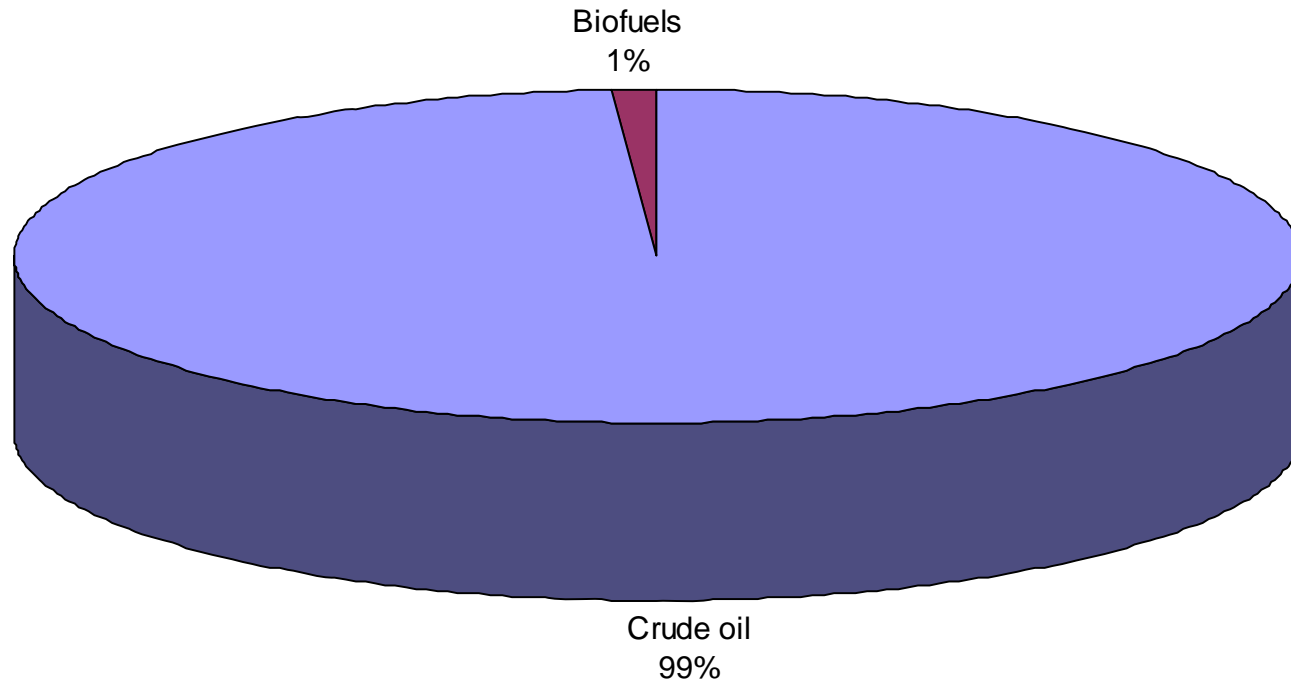
Biomass Materials

- **Developed countries:**
 - Low or negative value
 - No demand at present time
 - High value in the near future
- **Developing countries:**
 - High value
 - Growing demand for fuel and feed

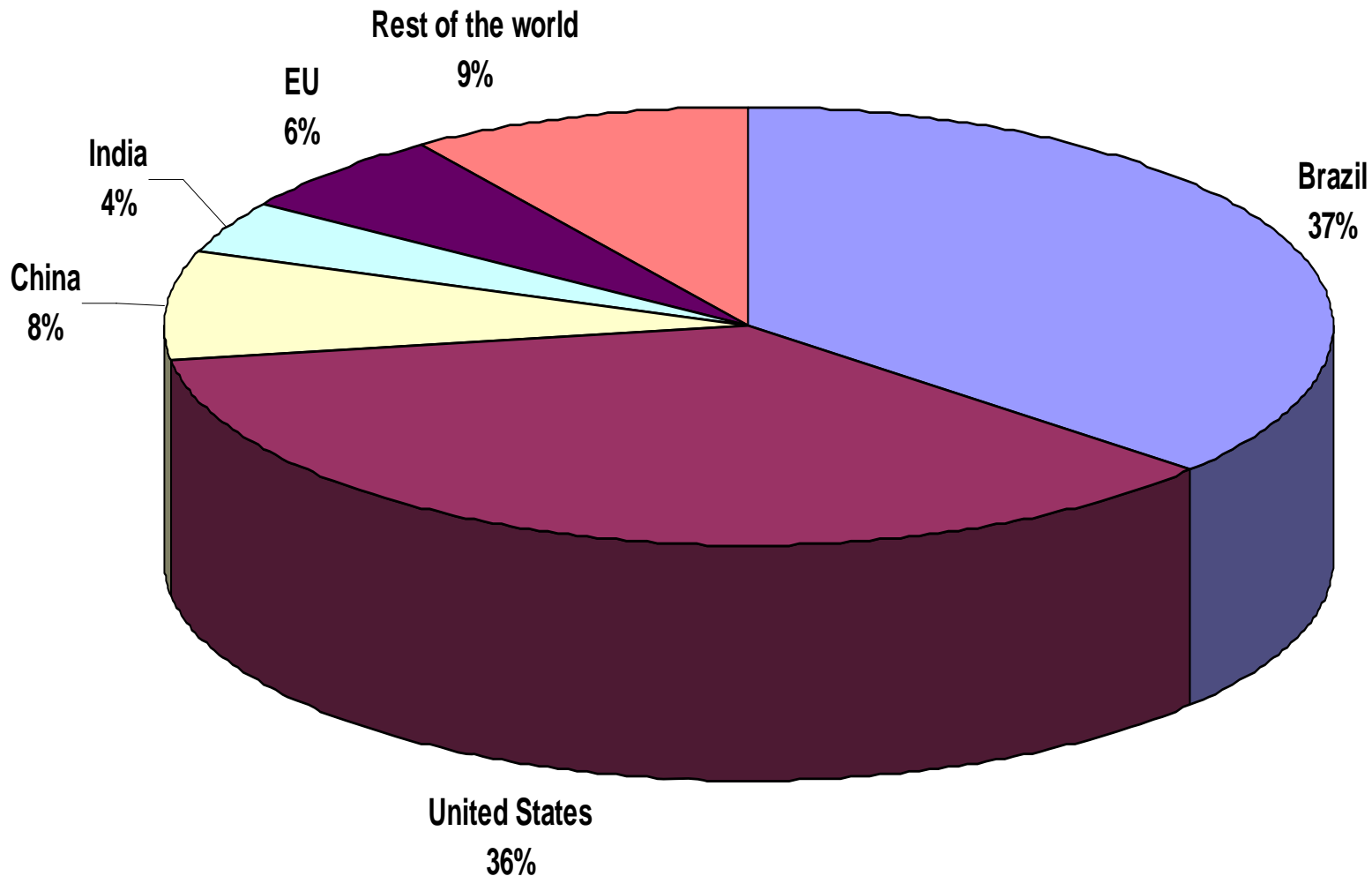
Biofuels Use

- **Ethanol:**
 - Additive (2 -10%)--U.S., Europe, India, China and rest of the world
 - Fuel (25-100%): Brazil
- **Biodiesel:**
 - Additive (1-2%)--U.S., Europe, Brazil
 - Fuel (100%)

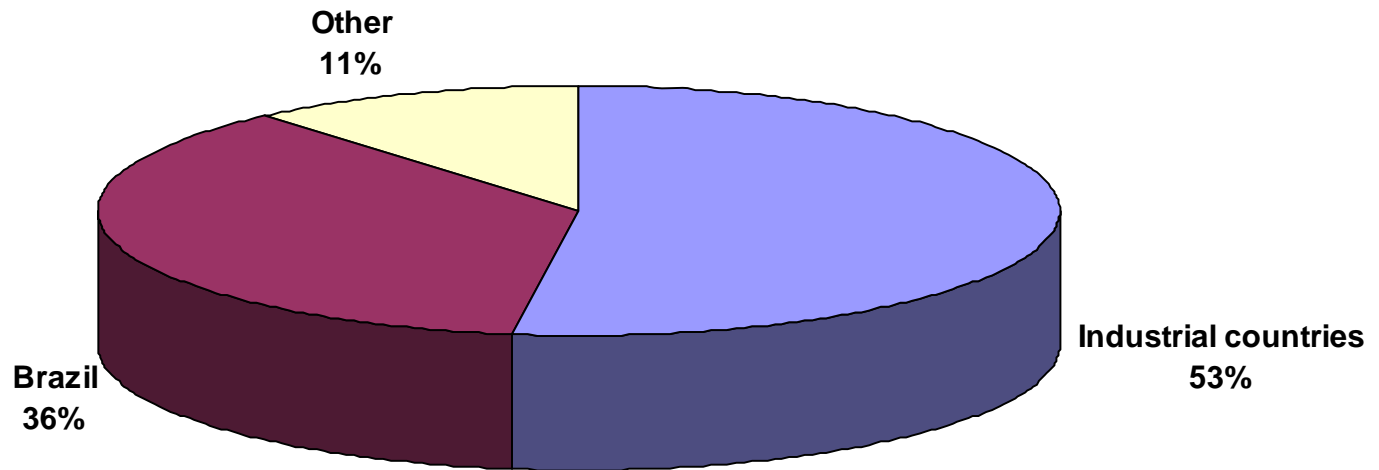
World: Crude oil and Biofuel Production



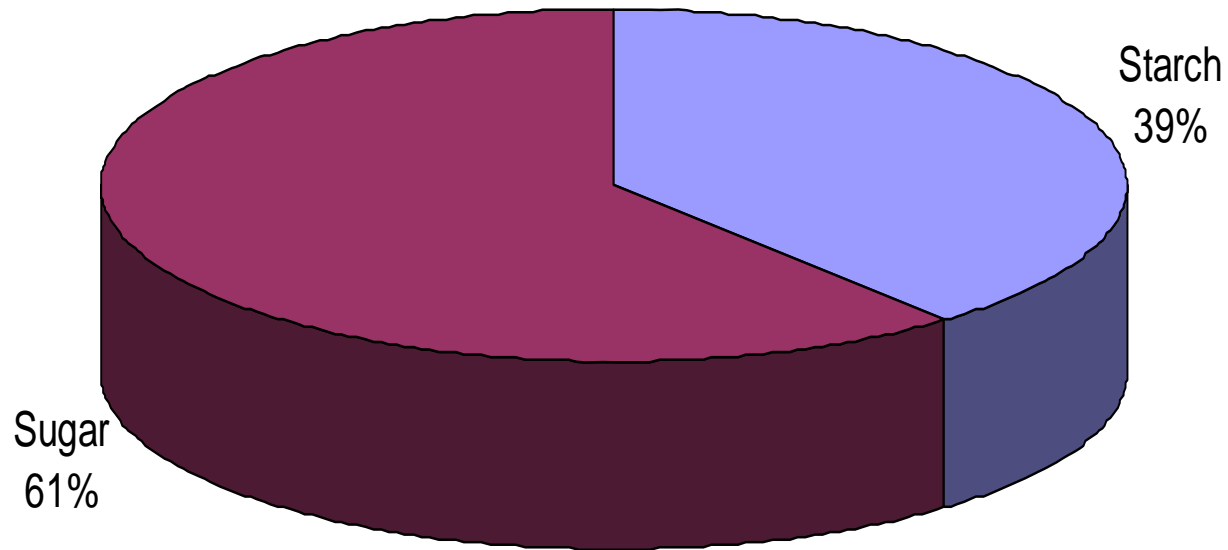
Ethanol: World Production by Country, 2005



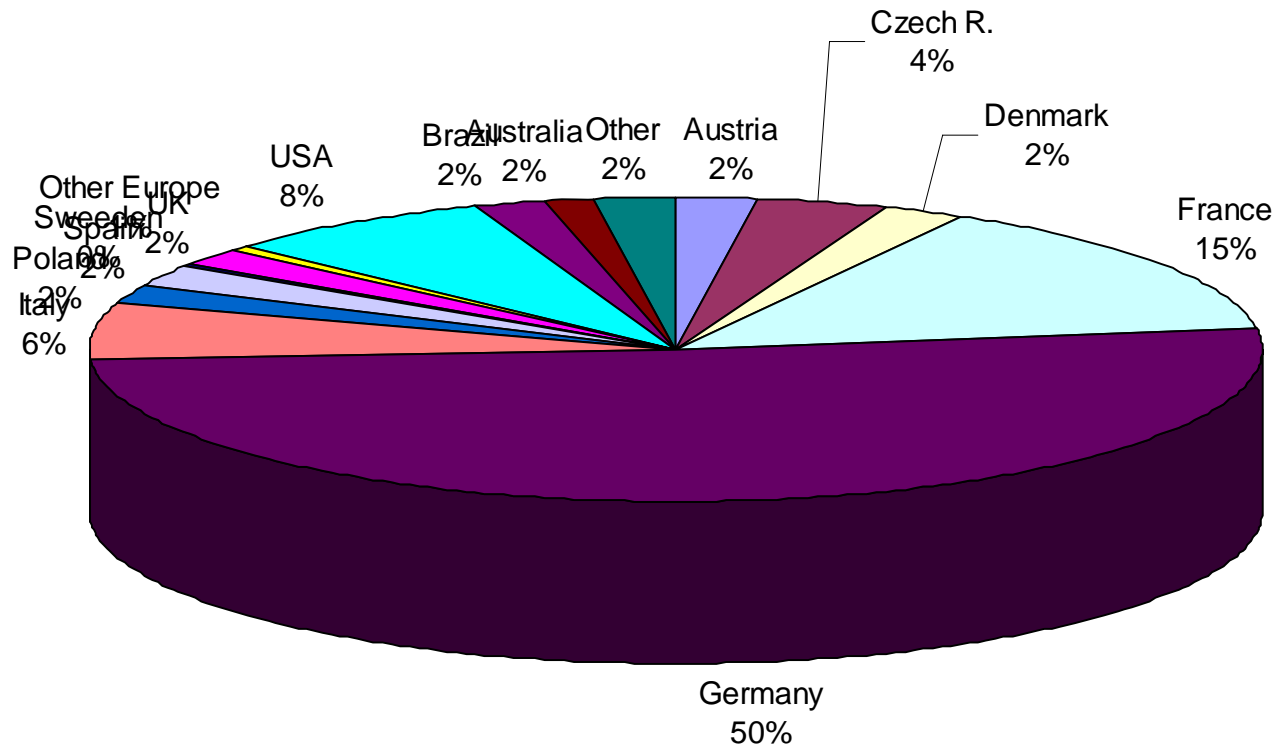
Ethanol: World Production



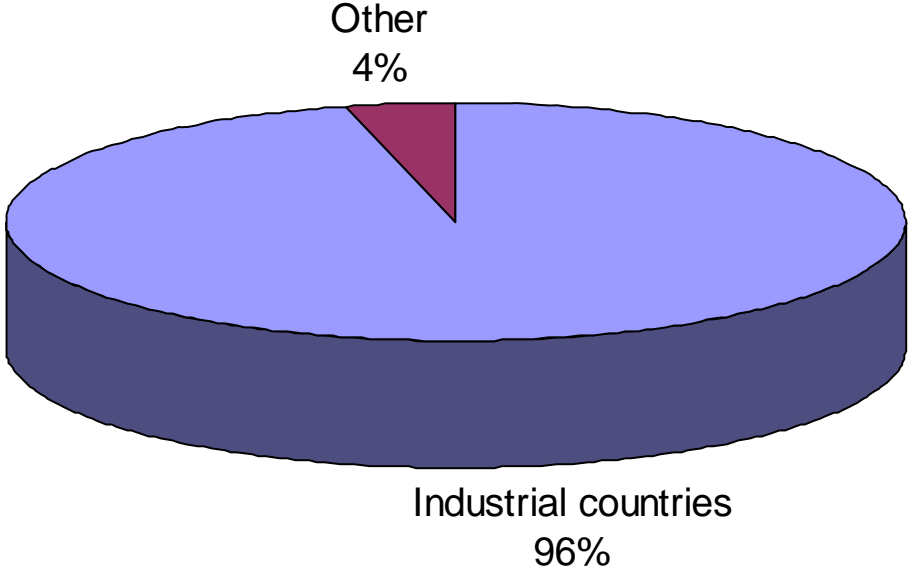
Ethanol: World Production: Raw Materials



World-Biodiesel Production



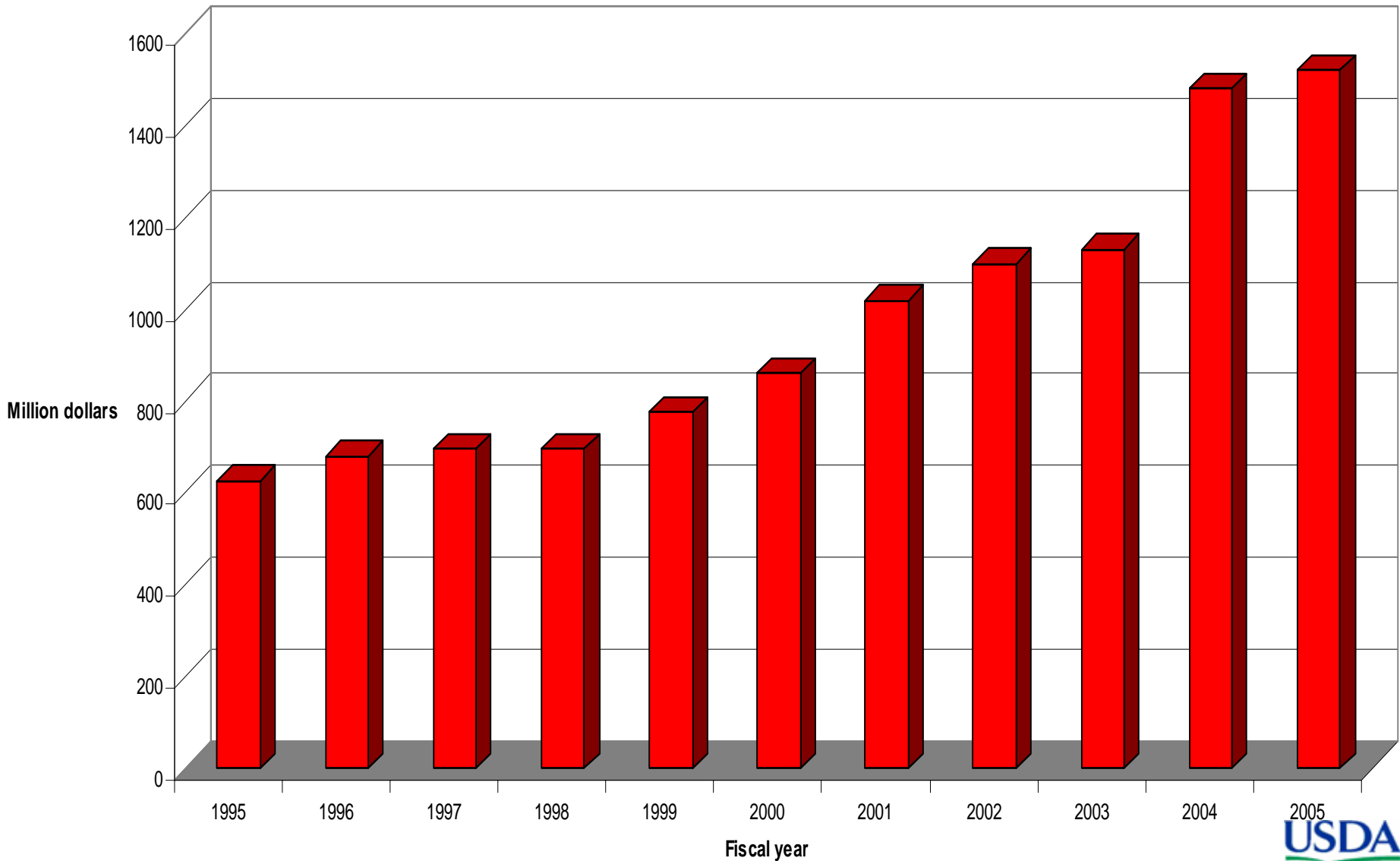
World: Biodiesel Production



Biofuels Production

- **High cost of raw materials**
- **Volatility in production of raw materials**
- **High costs of processing, storage, and distribution**
- **Require incentives such as tax exemption, mandates, and direct subsidies**
- **Increase food prices**
- **Environmental damage**

Ethanol Income Tax Credit, United states



Biofuel Production: Short Run and Long Run

- **Biodiesel:** remains as additive
- **Ethanol:**
 - Short run- fuel additive, except in Brazil
 - Long run- may be as fuel made from cellulosic materials

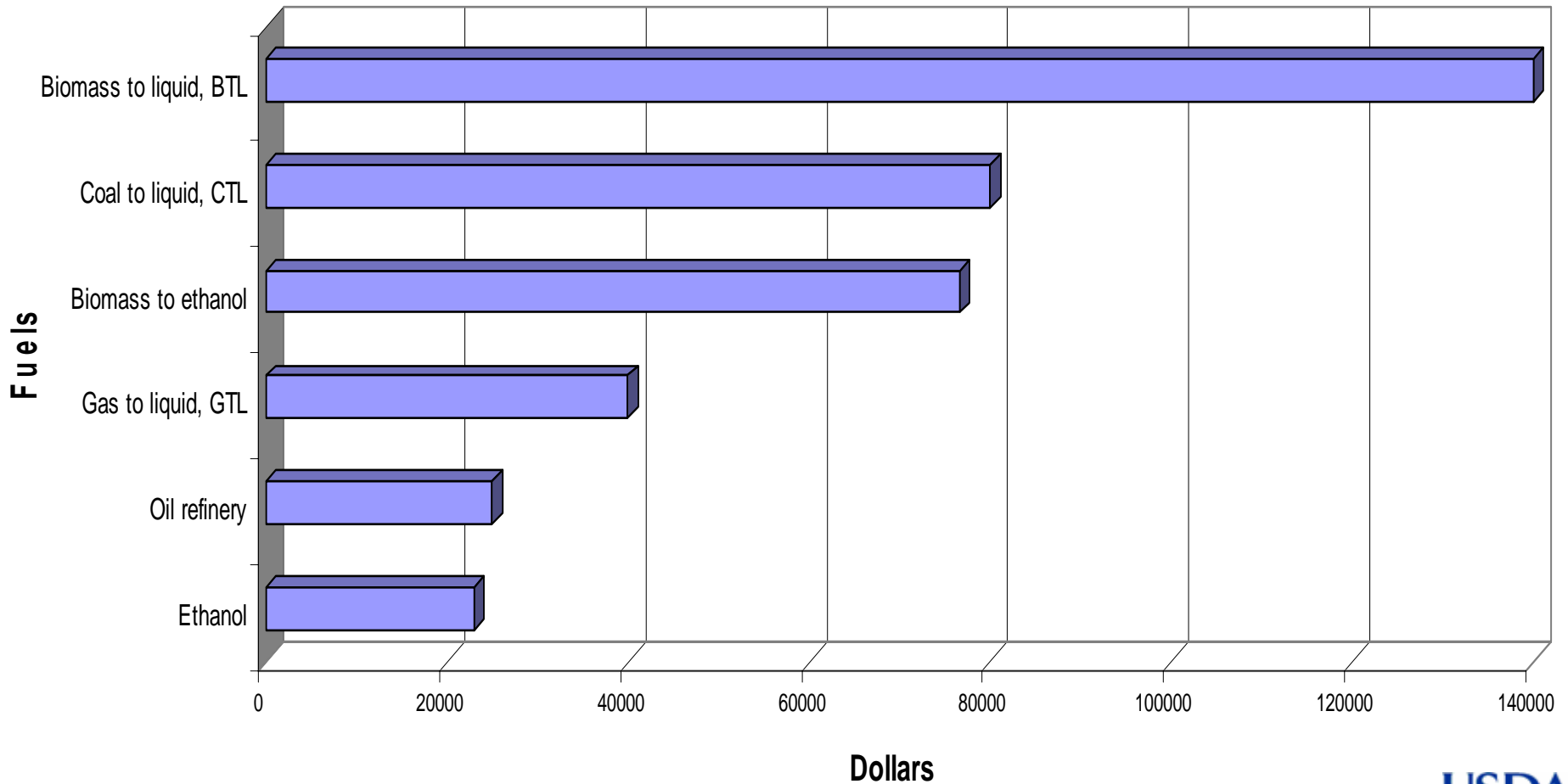
Countries with Excess Land Resource and Surplus of Ag. Commodities

- **United States**
- **Brazil**
- **European Union**
- **Australia,**
- **China**
- **India**
- **Philippines**

Biofuel Production Barrier

- **High cost of raw materials, specially starch and sugar**
- **High cost of converting biomass to biofuel**
- **High capital costs of biomass-ethanol plant**
- **Lack of infra-structure in distribution of biofuel**
- **Lack of funds for R&DD for biomass feedstock production**

Capital Investment Per Barrel Per Day



Value-Added Benefits per Liter

- **Corn to ethanol:**

• Corn 2.27 kilo	-\$0.18
• Ethanol 1 liter	+\$0.50
• Byproducts, DDGS	+\$0.05
• CO2	+
• Value of ethanol & byproducts	+\$0.55
Value-added	+\$0.37

- **Soybeans to biodiesel:**

• Soybeans 4.78 kilo	-\$0.95
• Biodiesel 1 liter	+\$0.87
• Byproducts, soymeal	+\$0.74
• Cost of methanol = Glycerin credit	
• Value of biodiesel & byproducts	+\$1.61
Value-added	+\$0.66

Value-Added Benefits-Continued

- **Cellulosic materials to ethanol:**
 - Biomass 1 metric dry ton -\$50
 - Biomass ethanol 416 liters +\$209
 - Excess electricity 350 kwh +\$21
 - CO² +
 - Value of ethanol and byproducts +230
 - Value-added +180

Nth plant



Biofuel Production Costs per liter

Cost	Corn-ethanol Dry-mill	Biomass-ethanol	Soy-biodiesel	Animal fats-biodiesel
Capital Costs	\$0.29	\$1.05 to \$1.3	\$0.09-\$0.18	\$0.09-\$0.18
Net feed stock	\$0.12	\$0.15	\$0.41	\$0.12
Processing	\$0.18	\$0.38	\$0.11	\$0.11
Total*	\$0.30	\$0.53 ¹	\$0.52	\$0.23

* Exclude capital cost

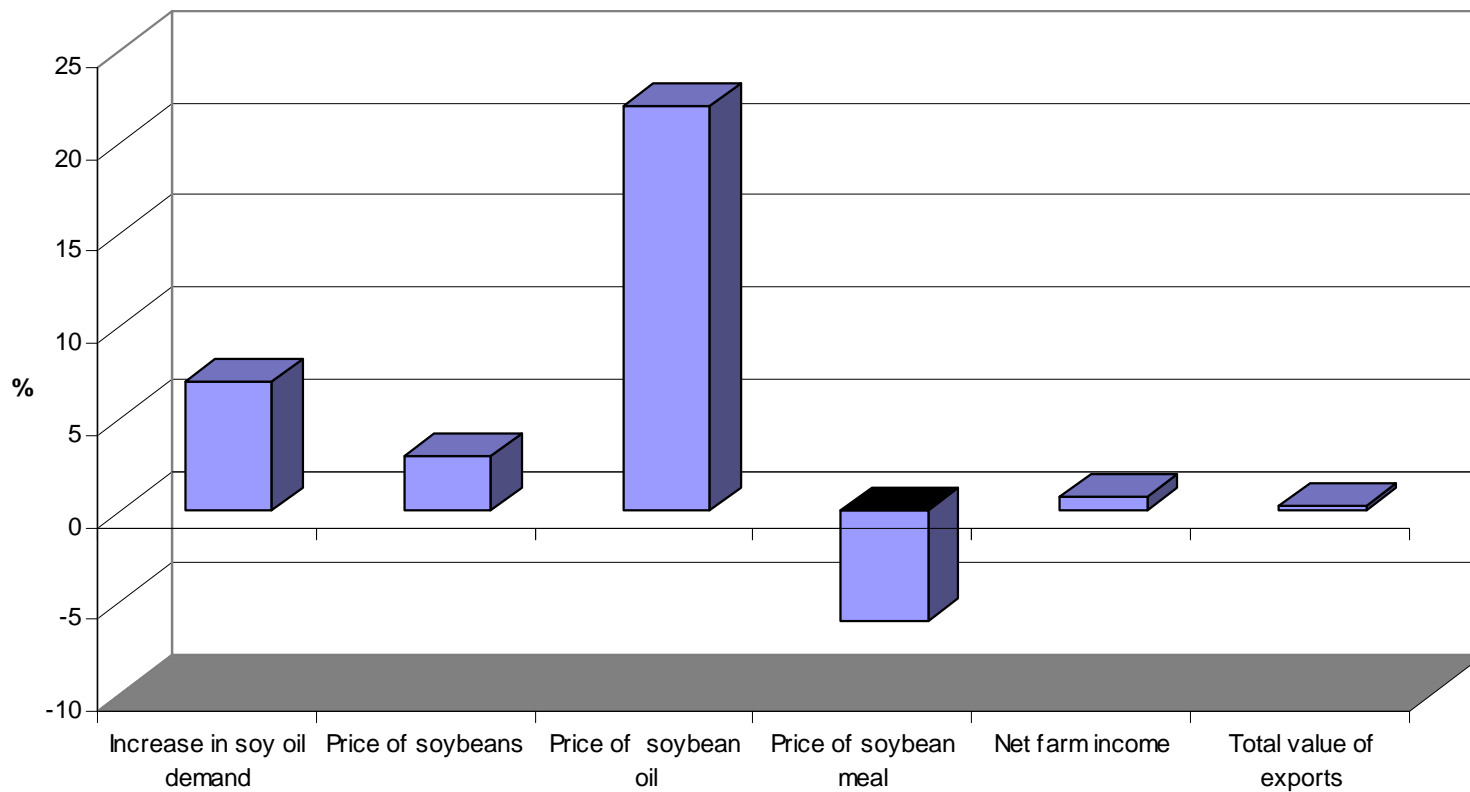
1 First plant



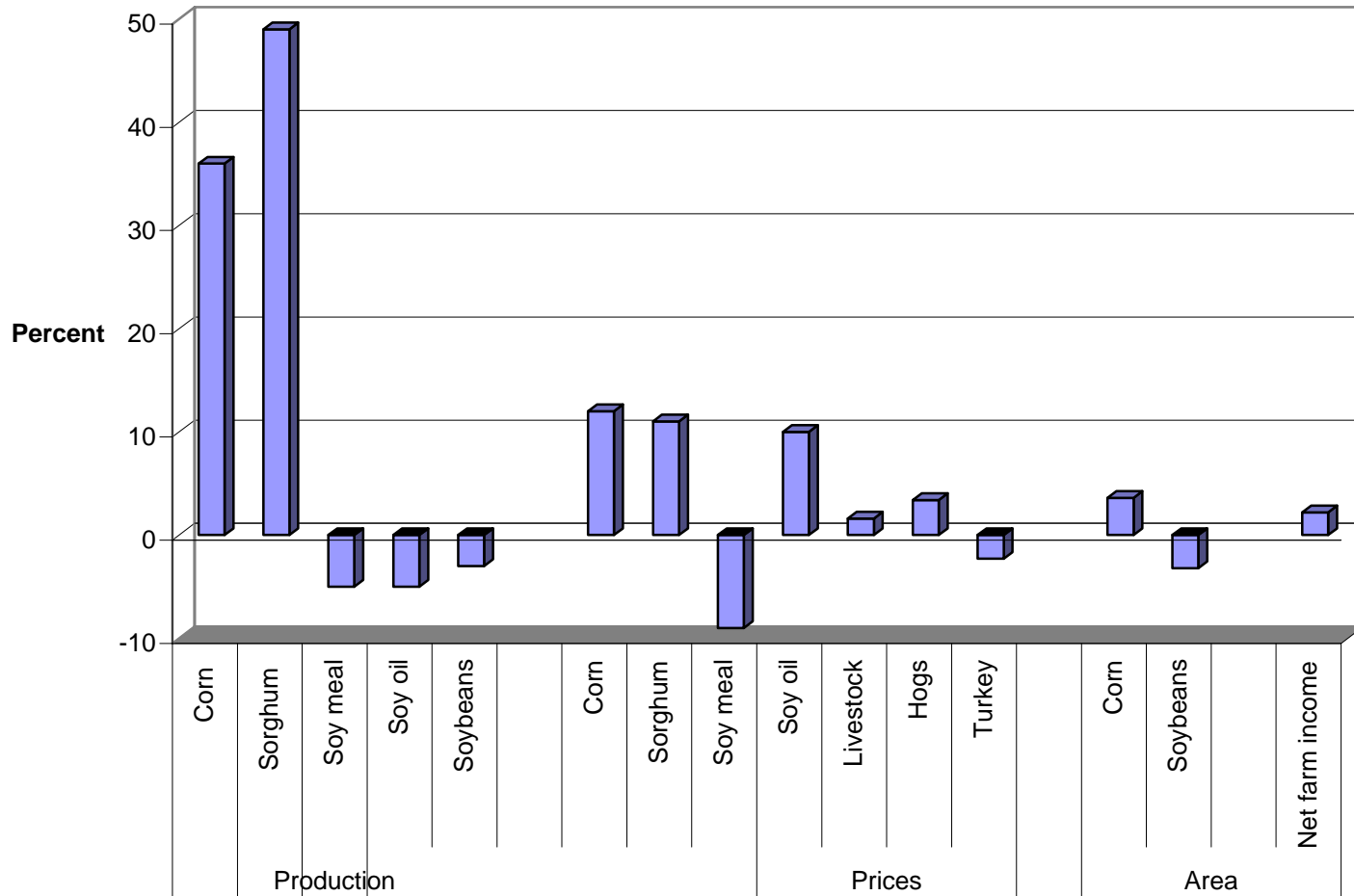
Economic Impacts of Biofuel Production

- **Reduces agricultural surplus and increases commodity prices**
- **Creates jobs in rural areas**
- **Increases farm income**
- **Reduces government payments**
- **Improves trade deficit**
- **Reduces dependency on foreign oil**

Economic Impacts from an Increase in Demand of 1.9 Billion lbs of Soybean Oil by 2012



Economic impacts of increasing ethanol production to 8 billion gallons in 2012



Policies and Regulations

Incentives:

- **Producers**
 - Mandates
 - Payment in kinds
 - Loan grantee and cost sharing
 - Subsidized feedstocks
- **Refineries and blenders:**
 - Excise tax credit
- **Consumers:**
 - Incentives for buying flexible fuel cars

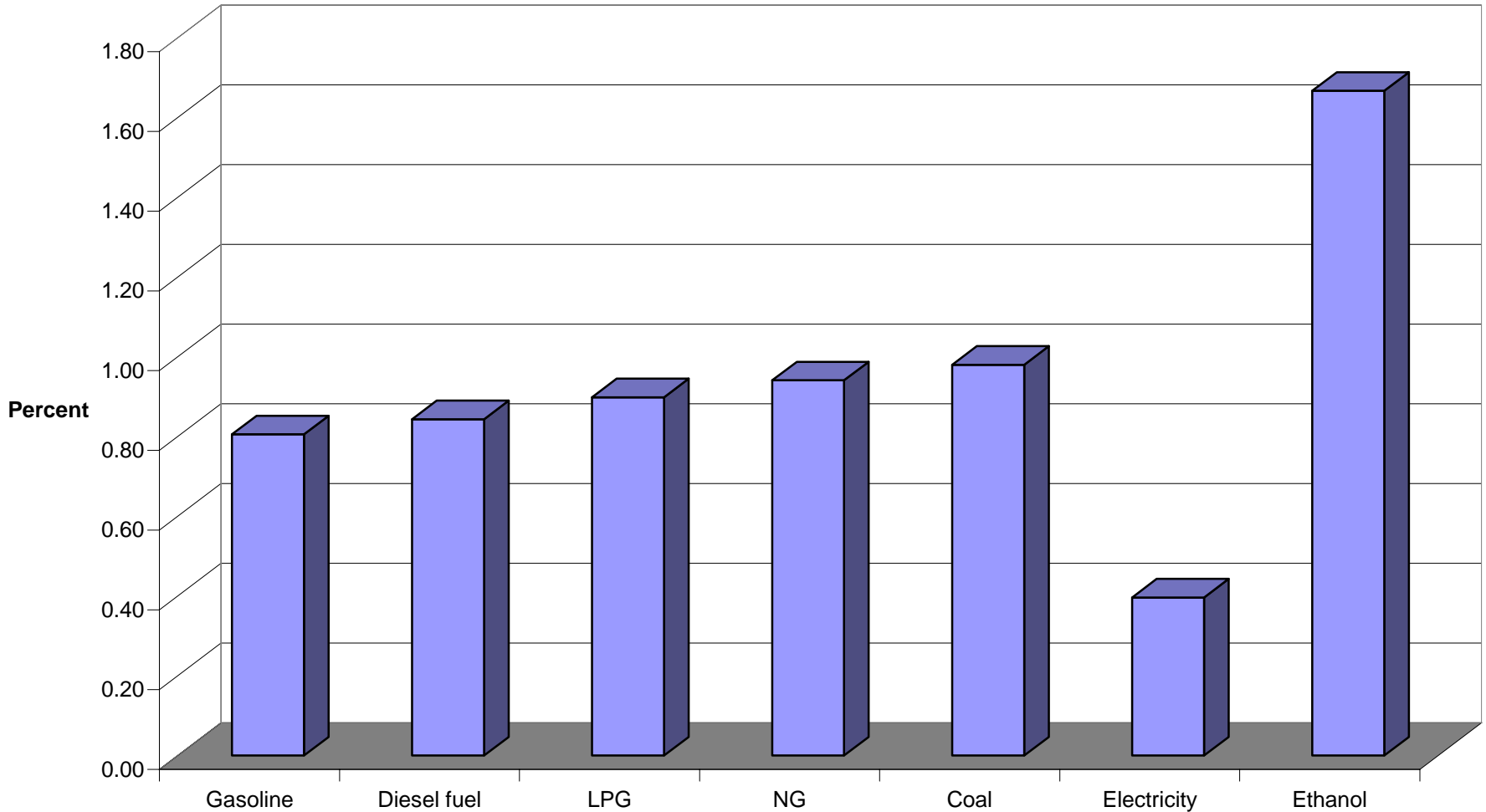
Viability of Biofuels Industry in Developing Countries

- **Depends on biofuel production costs relative to market based prices of gasoline and diesel**
- **Depends on impacts of trade liberalization on prices of feedstock**
- **Depends on prices of imported fuels in land-locked countries relative to domestic biofuel prices**
- **Depends on availability of surplus feedstock or non-crop feedstock**

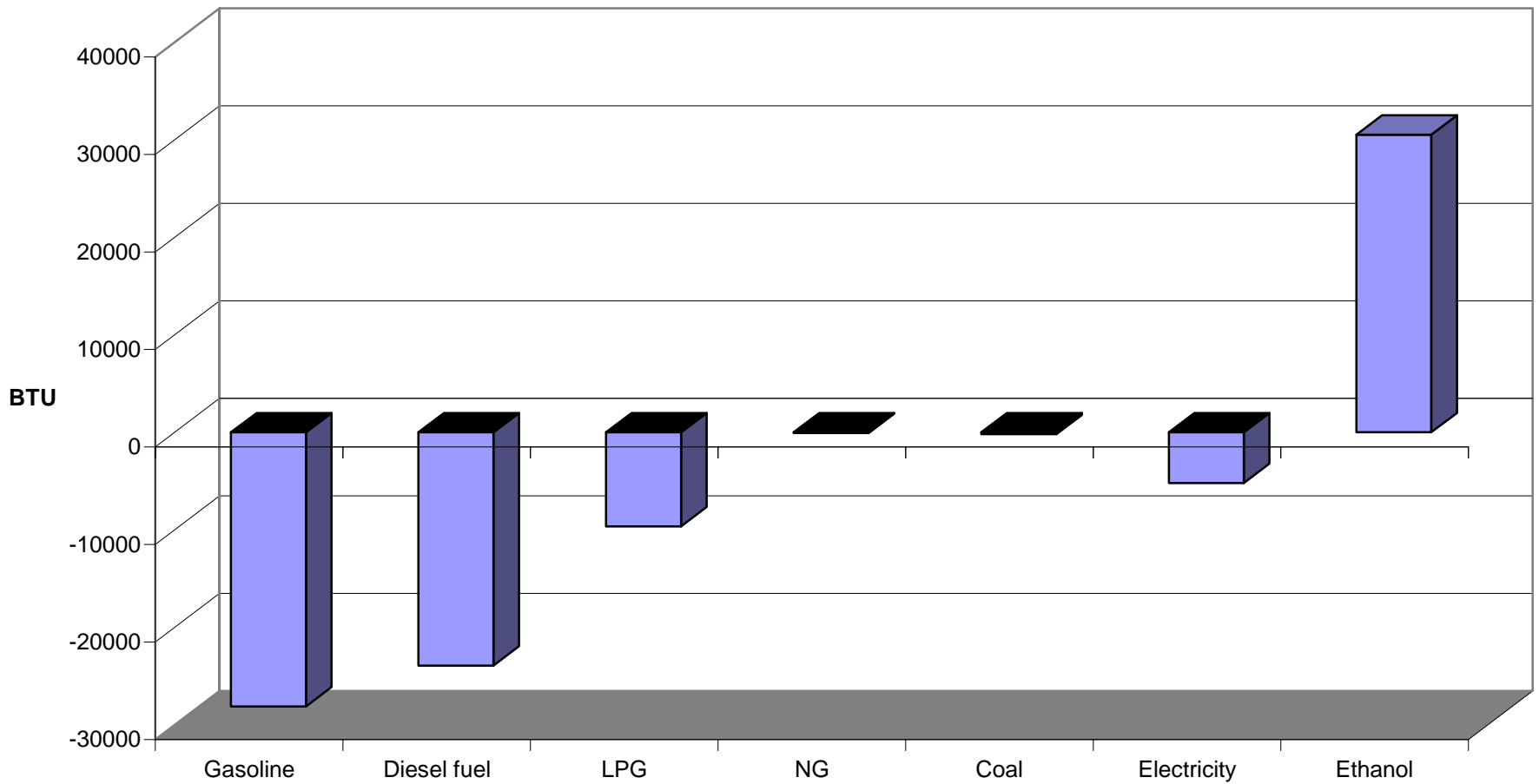
Net Energy Balance of Biofuel— Continued

- **The net Energy Balance (NEB)=energy content of a fuel minus the energy content of petroleum and energy sources required to produce it**
- **The net energy ratio (NER)= energy output divided by energy input**

Net energy ratio of ethanol and fossil fuels



Net energy balance of ethanol and fossil fuels



Net Energy Balance of Biofuels

- **There are two camps:**
 - Negative--Patzek, and Pimentel
 - Positive– Wang, Graboski, Shapouri, and Farrell
- **The results depend on assumptions, quality of data (farm energy inputs), allocation of total energy to ethanol and byproducts, biofuel types, and advanced technologies in crop production and conversion**

Impacts of New Technologies on Net Energy Balance

- **Higher crop yield per hectare**
- **Lower energy and chemical use per ton**
- **Higher ethanol yield per ton of feedstock**
- **Lower energy use in conversion of feedstock to biofuels**

Net Energy Ratio of Biofuels

- **Ethanol:**
 - Corn-ethanol--1.29 - 1.67
 - Sugarcane-ethanol--8 – 9
 - Biomass-ethanol--4.4 – 6.6
- **Biodiesel:**
 - Soy-biodiesel--3.2

CONCLUSIONS

- **Biofuels production is expected to increase world prices of agricultural commodities, unless raw materials are produced in non cropland areas**
- **Biofuels could lower fuel dependency of oil importing countries**
- **Biofuels production and use create jobs and reduces greenhouse gas emissions**