BIOENERGY PRODUCTION: ECONOMICS, POLICIES, AND ENVIRONMENTAL CONSIDERATIONS

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From Concept to Commercial Process

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Why Bioenergy?

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

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OVERVIEW

- **Bioenergy:**
  - Production
  - Economics
  - Policies and regulations
  - Environmental benefits

What is Bioenergy?

- **Biopower**
- **Biofuels:**
  - Ethanol
  - Biodiesel
  - Biocrude
  - Fischer & Torpsch
- **Biogas**

Biomass Feedstocks

- **Crops containing**:
  - Starch- grains, roots, etc.
  - Sugar- sugar beets, sugar cane, sweet sorghum, etc.
  - Oil-soybeans, rapeseed, peanuts oil, etc.
  - Energy crops
- **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.

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Biopower

- **Feedstock: Biomass,** mostly wood
- **Power plants:**
  - Dedicated
  - Cofiring
- **Process:**
  - Direct combustion and steam turbine
  - Gasification and gas turbine
  - Integrated gas turbine with combined cycle IGCC

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Status of Ethanol Industry

- **Number of operating ethanol plants (95), Plants under construction and expansion (41)**
- **Current production capacity,16,465 million liters per year (MLPY)**
- **2005 production, about 15,000 ML**
- **Projected production capacity, 20,800 MLPY by late 2006**
- **Size, less than 4 to over 1,100 MLPY**
- **Location, 21 States**
- **Process, wet and dry**
- **Feedstock %:**

Corn	97
Sorghum	2
Waste	1

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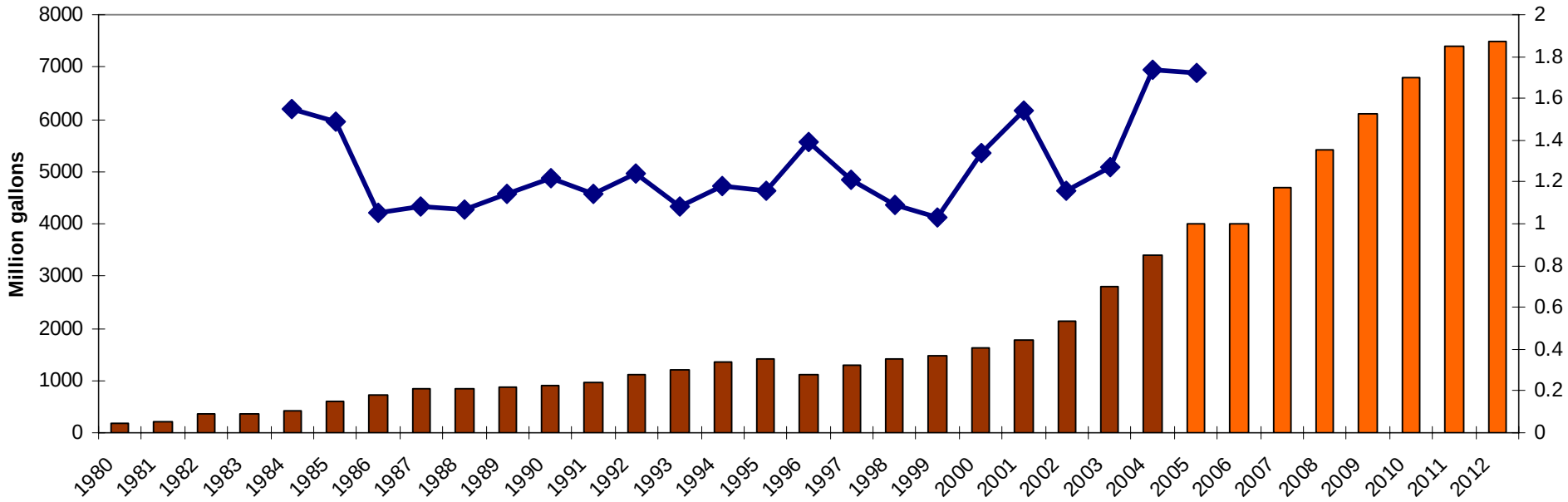
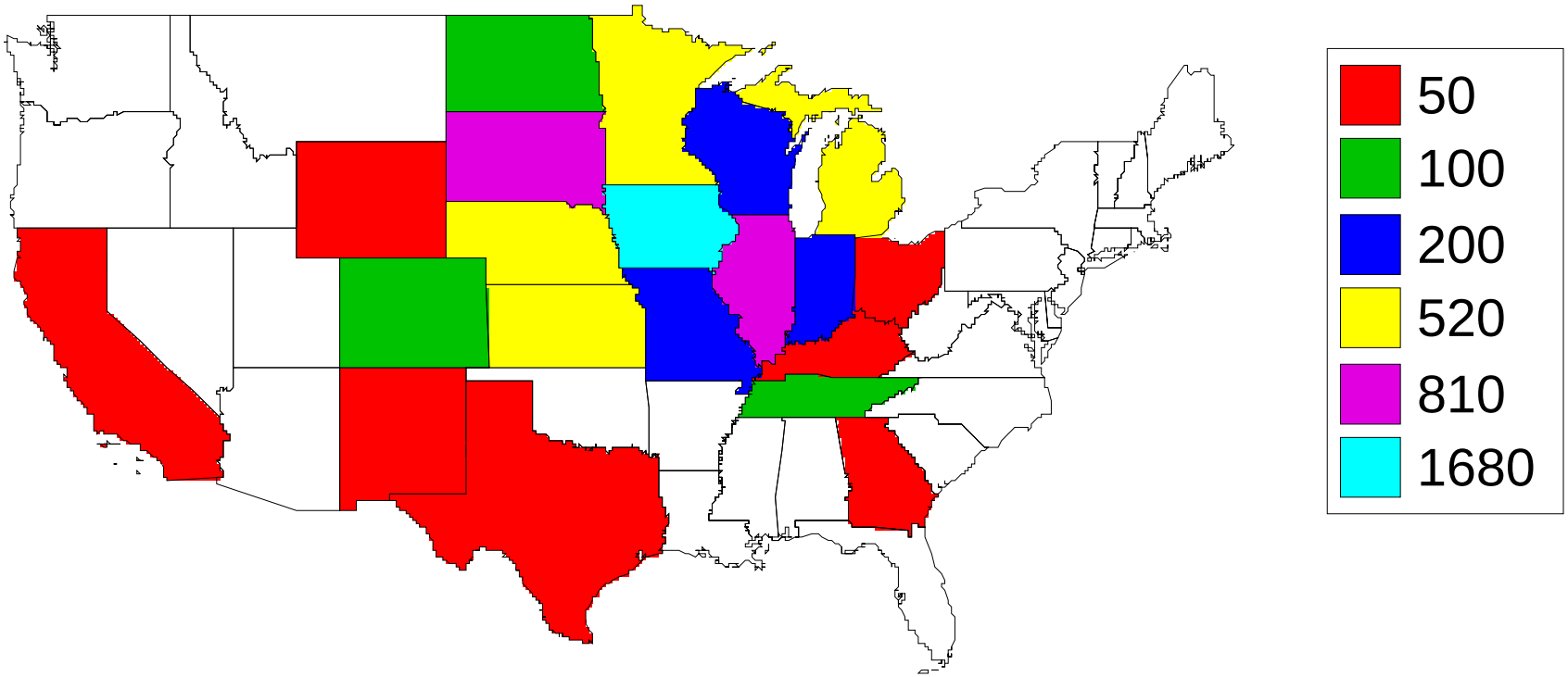
Ethanol Production and Prices



US ethanol production Capacity



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Status of Biodiesel Industry

- **Active plants, 45**
- **Plants under construction or expansion, 58**
- **Current production capacity, about 700 million liters per year (MLPY)**
- **2005 production, 200 million liters**
- **Projected production capacity,1,100 MLPY**
- **Size, less than one to over 100 MLPY**
- **Feedstock %:**

Soybean oil	90
Animal fats & yellow grease	10

- **Biodiesel could be used as a neat fuel (B100) or could be blended with petroleum diesel fuel from 1 to 20 percent (B1-B20)**

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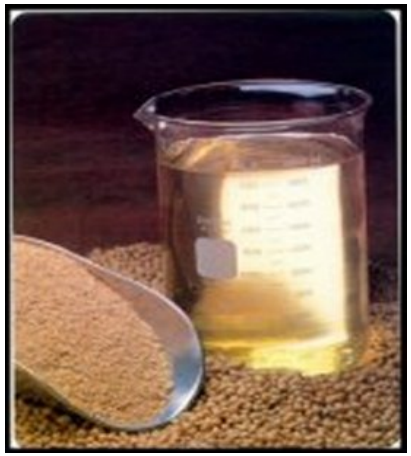


Biodiesel

(Catalyst)

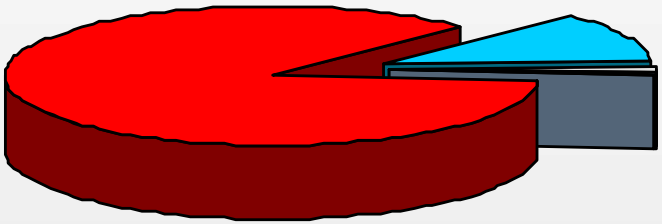
100 pounds Soy Oil or Animal Fats	+	10 pounds Methanol	=	100 pounds Biodiesel	+	10 pounds Glycerine

B100 = Biodiesel
Specified by ASTM D 6751

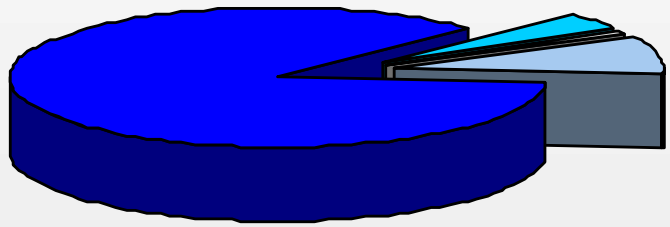
B20 = 20 % B100 blended with 80% petrodiesel

Production Process Transesterification

Process Input Levels = Process Output Levels



- Methanol 12%
- Catalyst 1%
- Neutralizing Agent 1%
- Oil 86%



- Methanol 4%
- Fertilizer 1%
- Glycerine 9%
- Methyl Ester 86%

Nothing is wasted

Economics

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

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Value-Added Benefits-Continued

- **Cellulosic materials to ethanol**:
  - Biomass 1 metric dry ton -$50
  - Biomass ethanol 416 liters +$209
  - Excess electricity 350 kwh +$21
  - CO^2 +
  - Value of ethanol and byproducts +230
  - Value-added +180

N^{th} plant

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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
Process-ing	$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

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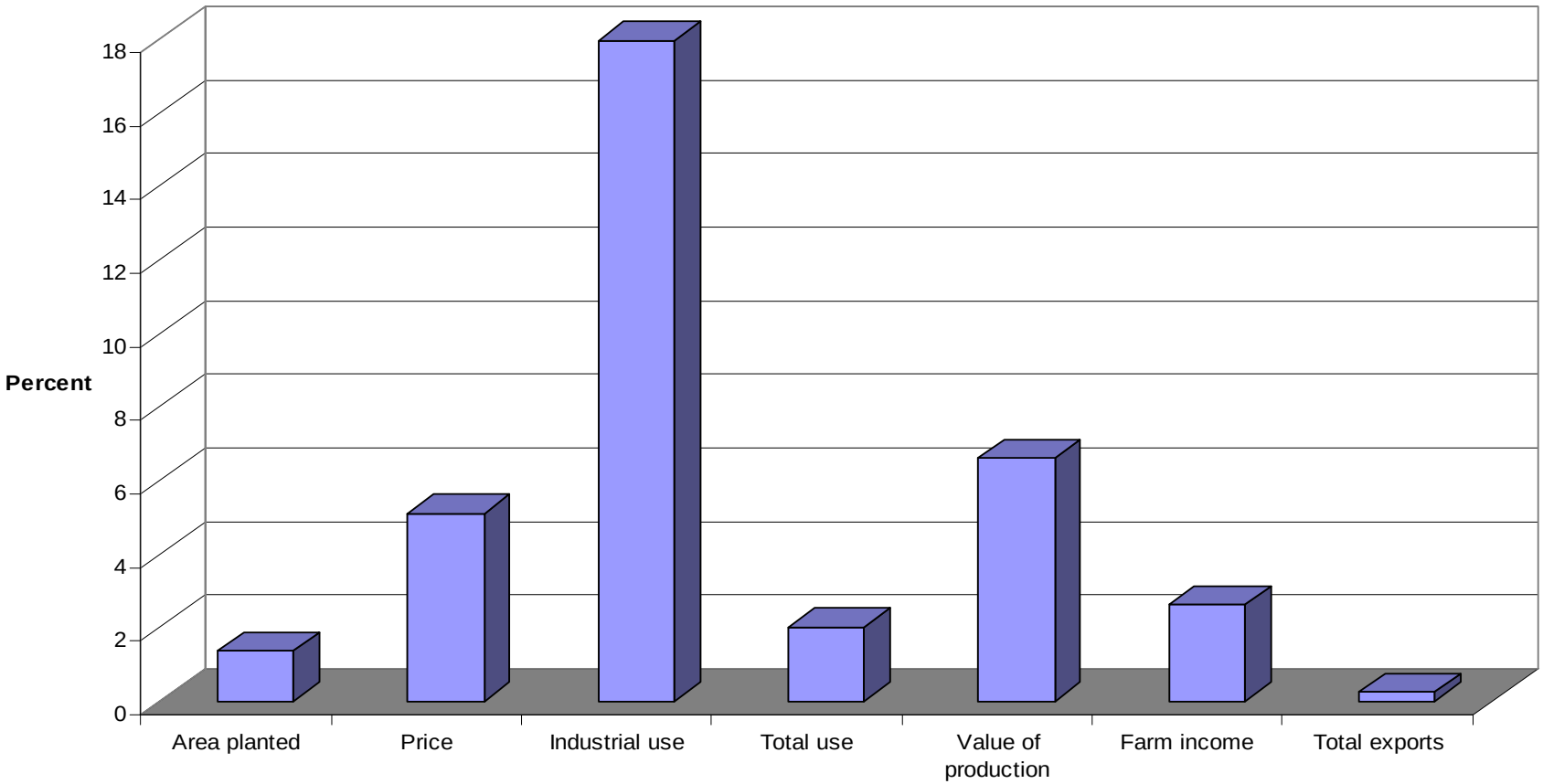
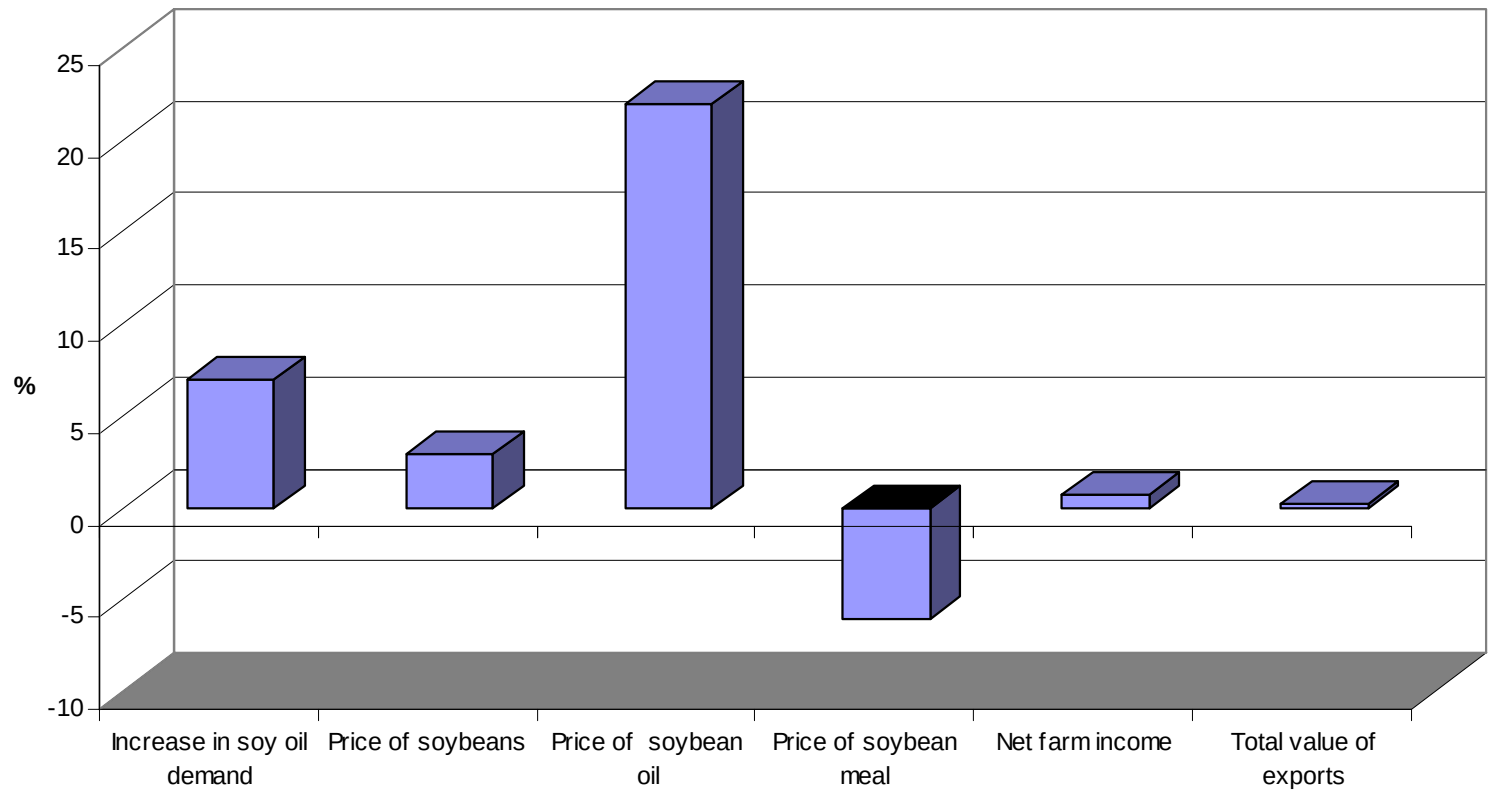
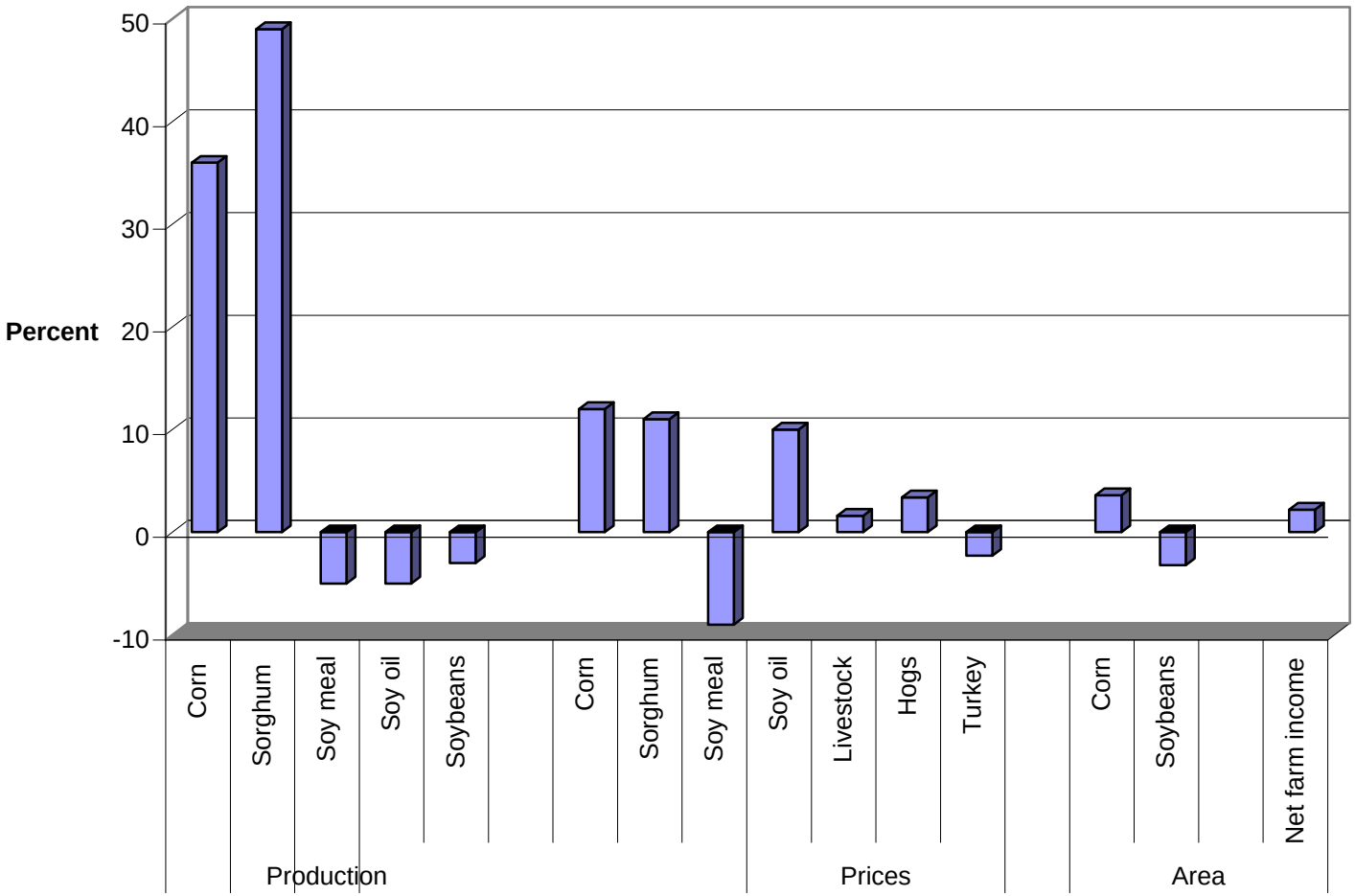
Economic Impacts of Increasing Corn-Ethanol Production by 1.4 Billion Gallons in 2012



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 & Regulations

Policies which Encourage Ethanol Use

Federal Incentives for Bifuels:

- Motor fuel tax exemption
- Tax credit to small ethanol producer
- Tariff on fuel ethanol imports
- Tax deduction on purchase of renewable fueled vehicles, E85
- Federal tax credit for biodiesel

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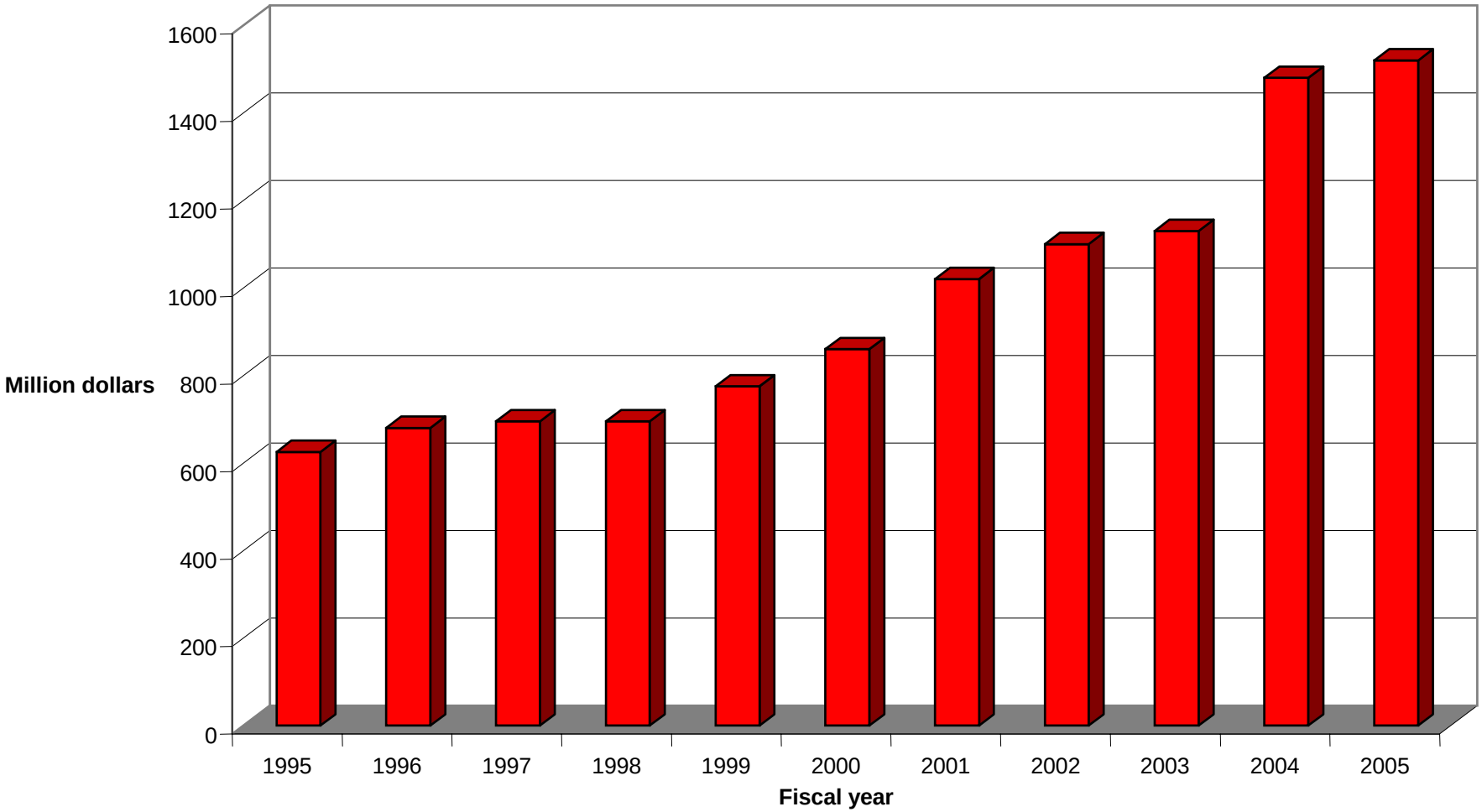
Ethanol tax expenditures



Source: U.S. Treasury

Farm Security and Rural Investment Act of 2002

- **Title IX, Energy**:
  - Federal procurement of biobased products ($1 M, 2002-07)
  - Biorefinery grants
  - Biodiesel fuel education program ($1 M, 2003-07)
  - Energy audit and renewable energy development program
  - Renewable energy systems & energy improvements ($23 M, 2003-07)

Farm Security and Rural Investment Act of 2002-- Continued

- Hydrogen and fuel cell technologies
- Biomass research and development ($14 M, 2003-07)
- Bioenergy program ($150 M, 2003-06)
- Renewable energy development loan and grant program

Impact of Energy Policy Act of 2005

- **Triples the biofuels use**
- **Allows increase in the renewable fuels standard (RFS) from 15 to 28 billion liters during 2006 to 2015**
- **Allows 946 million liters a year of cellulosic-ethanol be included in the RFS from 2013**
- **Gives flexibility to refineries by creating a credit trading for biofuels**

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Energy Policy Act of 2005-- Continued

- Enhances the air quality standards
- No liability protection for MTBE
- Creates grant and loan guarantee programs for cellulose ethanol and ethanol production from sugar
- Allows tax relief provisions

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Energy Policy Act of 2005--Continued

- Targeted biomass research and development
- Production incentives
- Procurement of biobased products
- Bioeconomy grants
- Other provisions, education and outreach and reports

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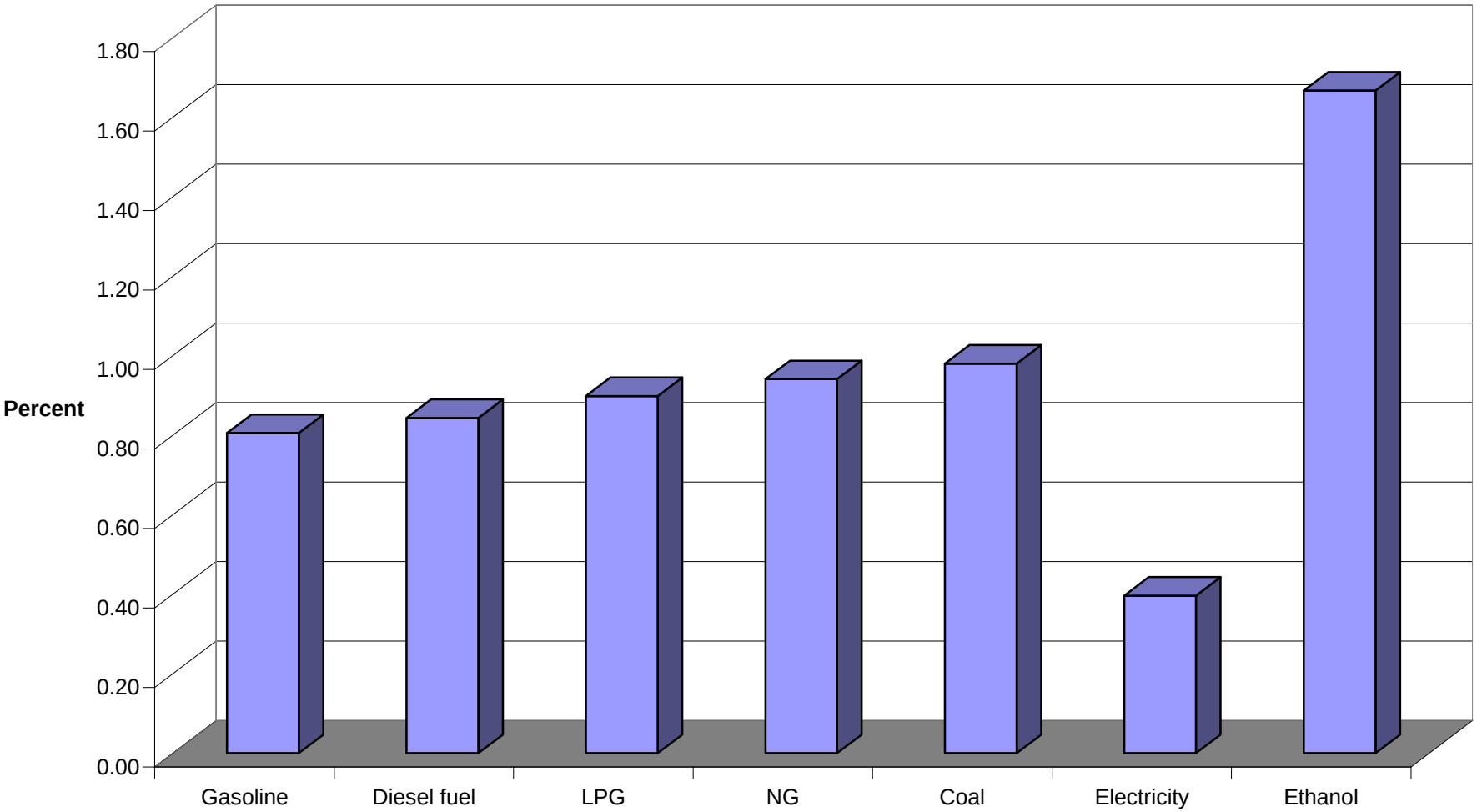
Net Energy Balance of Bioenergy

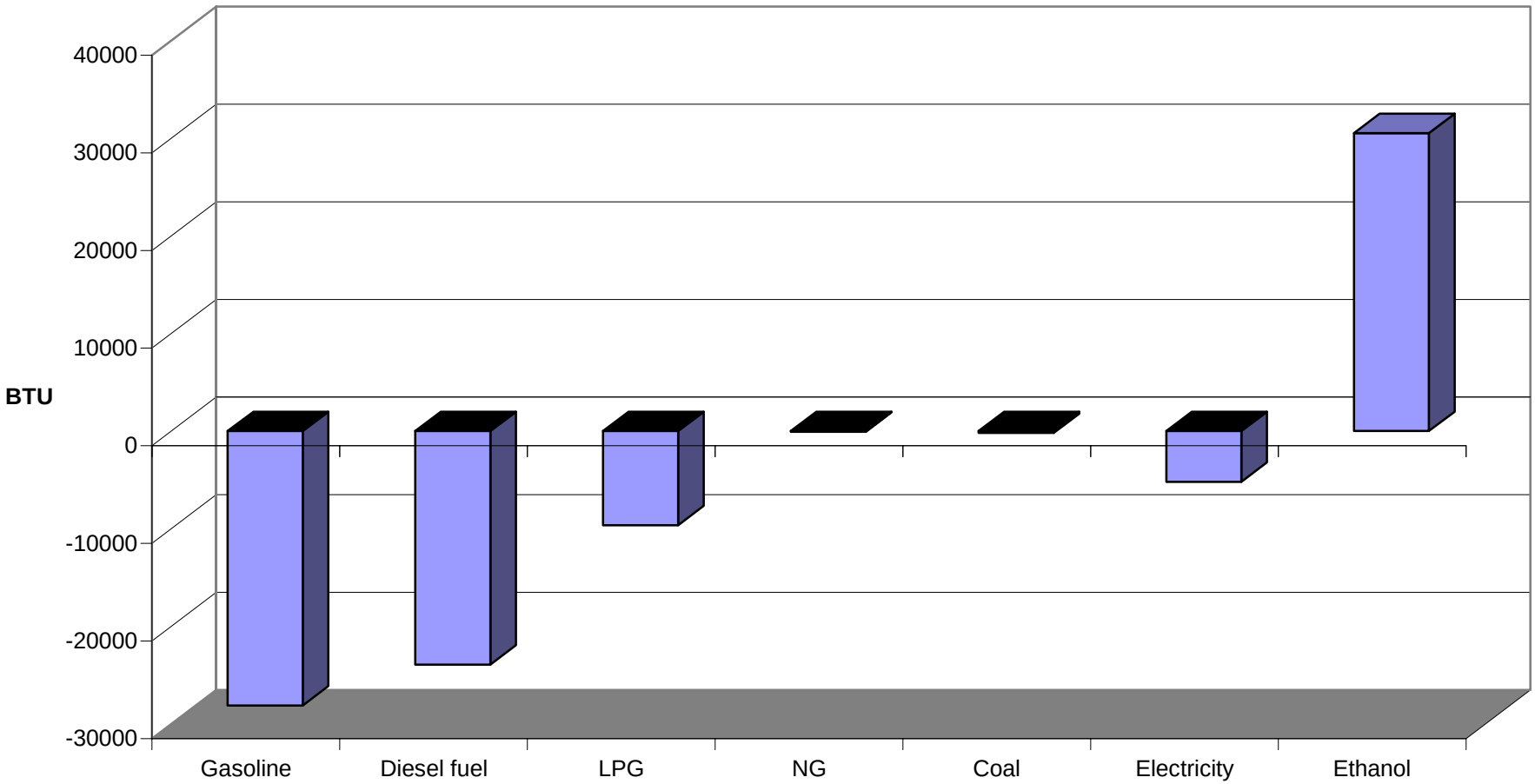
Net Energy Balance (NEB) and Net Energy Ratio (NER)

- **NEB**- is defined as energy content of a fuel, minus the energy content of petroleum and energy sources required to produce it
- **NER**- is defined as energy output divided by energy input

Net energy ratio of ethanol and fossil fuels



Net energy balance of ethanol and fossil fuels



Impacts of New Technologies on Net Energy Balance

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

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Impacts of Bioenergy on Environment

- Bioenergy production reduces tailpipe and other toxic emissions and improves air quality
- Cleaner air reduces diseases associated with breathing air
- Lowers the emission of NO^x, SO^x, CO and other harmful emissions
- Reduces greenhouse gas emissions

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CONCLUSIONS

- **Bioenergy production reduces country dependency to foreign oil and reduces fossil fuels consumption**
- **Bioenergy production reduces greenhouse gas emissions, creates jobs and improves economic conditions of rural areas**
- **To expand bioenergy production, public policies and regulations are necessary**

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