

# THE FUTURE OF ETHANOL

Presentation to

## **API Southern Region/ State Working Groups Spring Conference Charleston, SC**

By

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# THE FUTURE OF ETHANOL

## Presentation Outline

- Introduction
- Brief History of Ethanol as a Fuel
- Current Status of Fuel Ethanol
- Regulatory Drivers for Ethanol as a Fuel
- Corn Ethanol's Challenges
- The Future of Fuel Ethanol
- Questions/Discussion



# Introduction

We've had plenty of experience with making ethanol over the years.



# History of Ethanol as a Fuel

Ethanol has been used as fuel in the United States **since at least 1908 with the Ford Model T** which could be modified to run on either gasoline or pure alcohol. Henry Ford designed the famed Model T Ford to run on alcohol saying that it was "the fuel of the future".

Ethanol was used well into the 1920's and 1930's to fuel cars alongside an effort to sustain a US ethanol program. Although these early efforts failed, oil supply disruptions in the Middle East and environmental concerns over the use of lead as a gasoline octane booster renewed interest in ethanol in the late 1970s.

Ethanol production in the United States grew from 175 million gallons in 1980 to approximately 6.5 billion gallons in 2007, with support from Federal and State ethanol tax subsidies, the mandated use of high-oxygen gasoline, and federal energy statutes.



# History of Ethanol as a Fuel

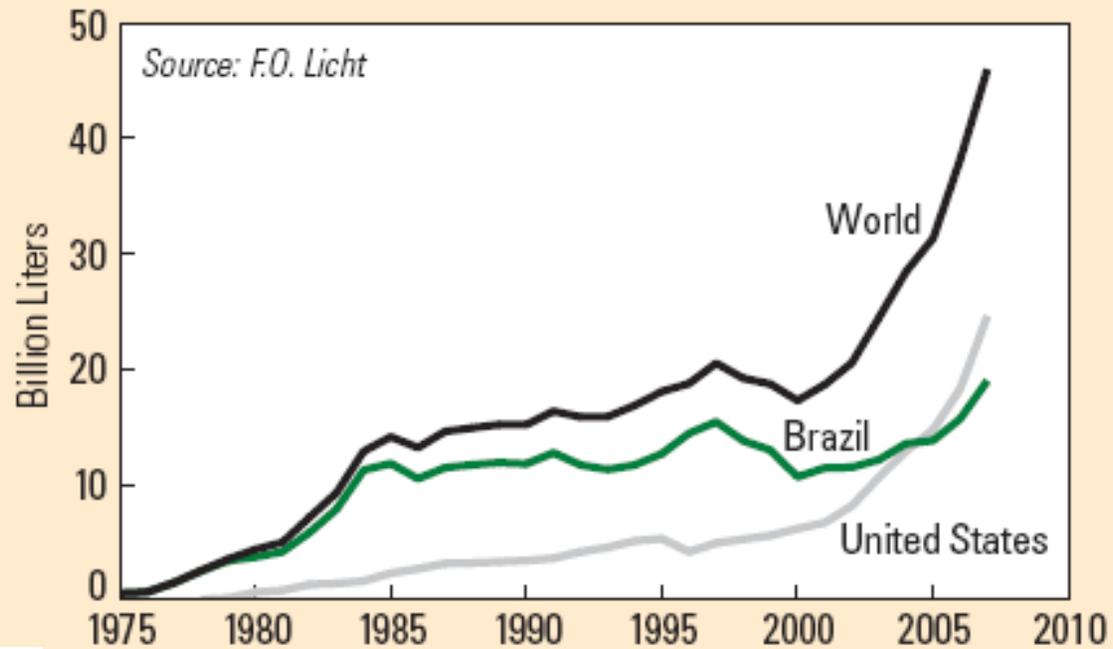
Year	Fuel Ethanol Production		
	World	Brazil	United States
	million liters		
1975	556	556	
1976	664	664	
1977	1,470	1,470	
1978	2,529	2,491	38
1979	3,533	3,383	150
1980	4,368	3,706	662
1981	4,977	4,163	814
1982	7,149	5,824	1,325
1983	9,280	7,861	1,419
1984	12,880	11,252	1,628
1985	14,129	11,820	2,309
1986	13,193	10,506	2,687
1987	14,599	11,457	3,142
1988	14,902	11,704	3,198
1989	15,191	11,898	3,293
1990	15,190	11,783	3,407
1991	16,348	12,752	3,596
1992	15,853	11,686	4,164
1993	15,873	11,297	4,542
1994	16,857	11,692	5,110
1995	18,066	12,671	5,299
1996	18,750	14,438	4,164
1997	20,517	15,423	4,921
1998	19,203	13,787	5,251
1999	18,711	12,978	5,572
2000	17,279	10,656	6,171
2001	18,655	11,434	6,684
2002	20,529	11,490	8,151
2003	24,459	12,140	10,617
2004	28,464	13,544	12,906
2005	31,340	13,813	14,755
2006	38,200	15,700	18,300
2007	46,000	18,999	24,605



Worldwatch Institute  
Vital Signs Online 2008

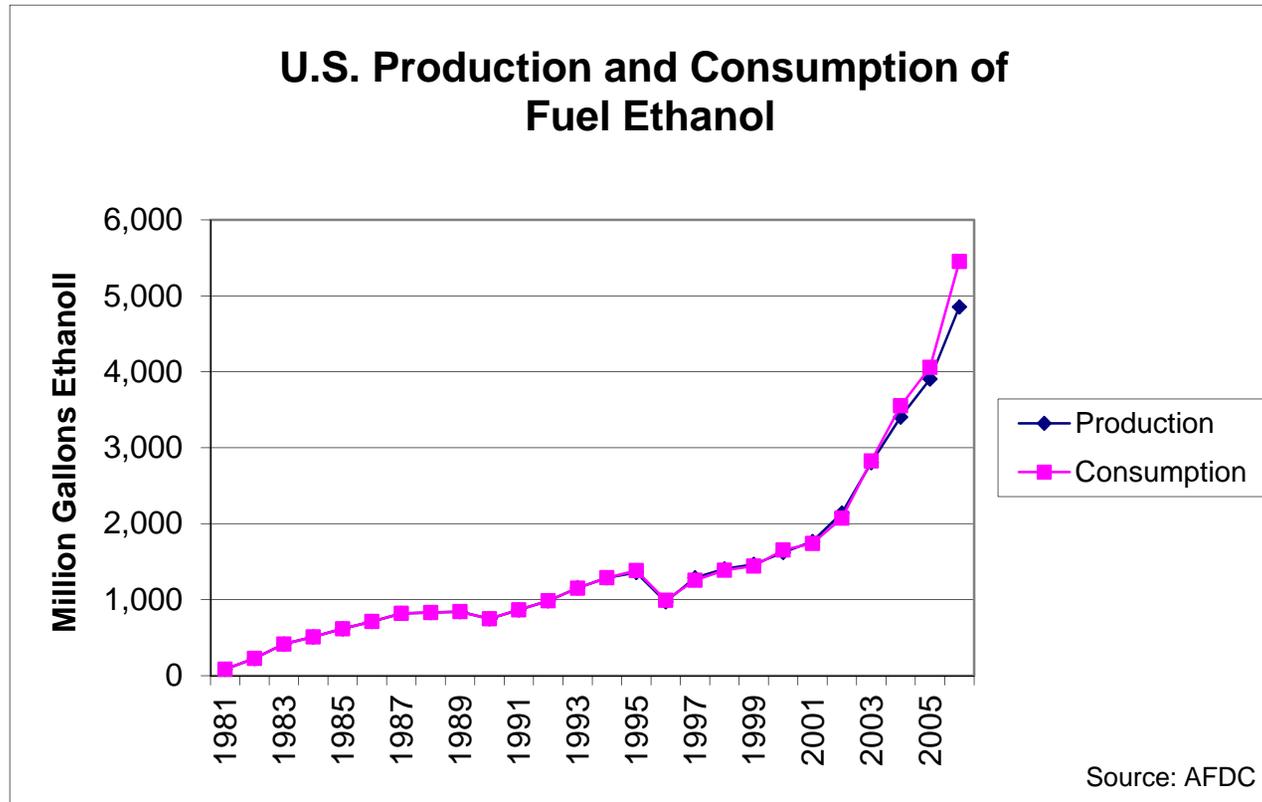
# History of Ethanol as a Fuel

**Figure 2. Fuel Ethanol Production in World, Brazil, and United States, 1975–2007**

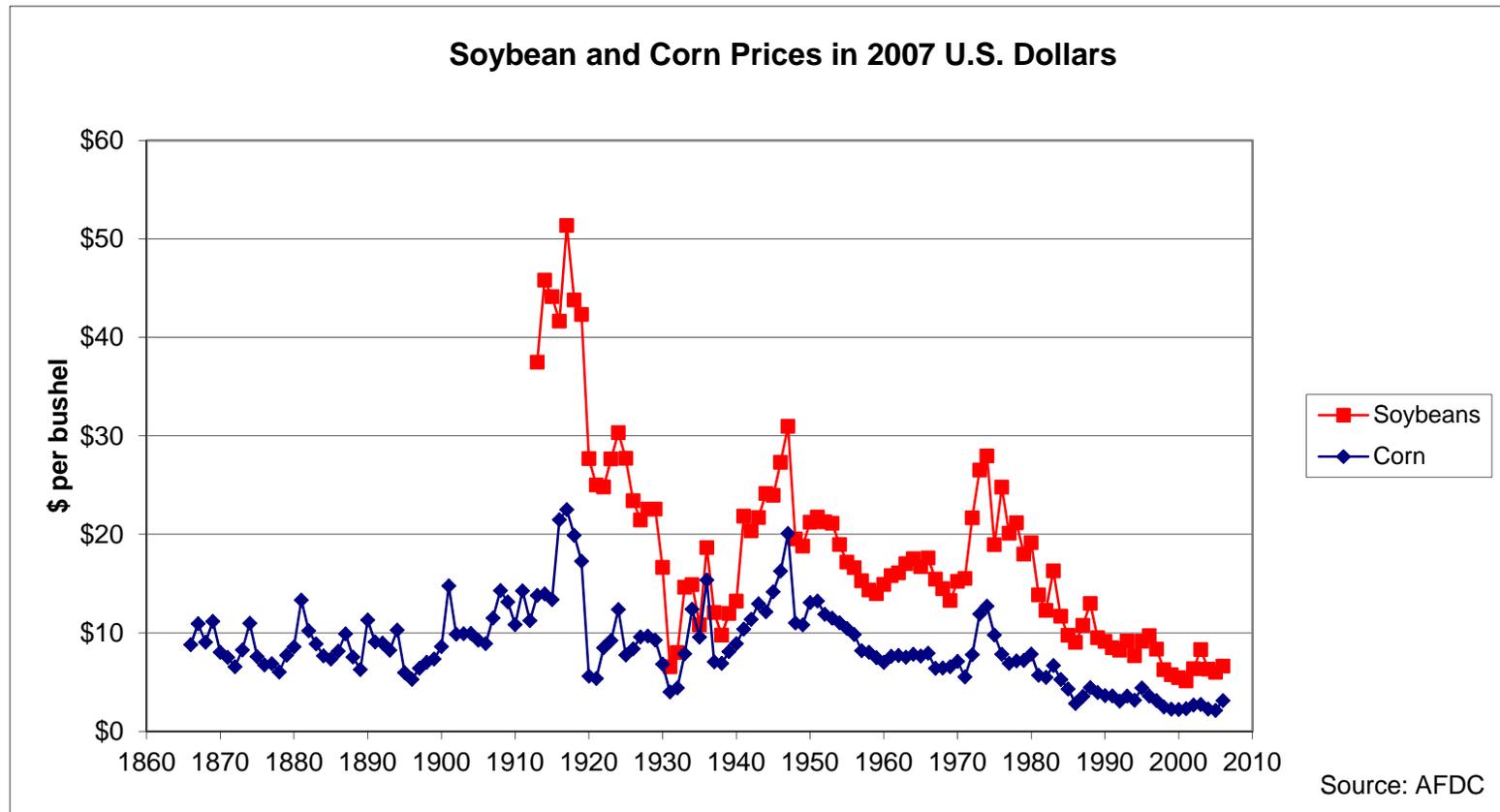


VITAL SIGNS ONLINE

# History of Ethanol as a Fuel



# History of Ethanol as a Fuel



# Regulatory Drivers for Ethanol as a Fuel

## 1990 Clean Air Act Amendments

- Specified that reformulated gasoline (RFG) contain oxygen – 2% by weight.
- MTBE and ethanol have been most commonly used.
- MTBE has fallen from favor because of groundwater contamination and toxicity concerns.
- The oxygenate requirement was lifted in 2006.

## Energy Policy Act of 1992 (Epect)

- Established requirements for purchasing AFVs for federal, state, and alternative fuel provider fleets.
- Employed both voluntary and regulatory approaches for encouraging the fundamental changes necessary to building a self-sustaining alternative fuel market.
- DOE launched the Clean Cities Initiative in 1993.

## Executive Order 13149, April 2000,

- Established a petroleum reduction goal of 20% by 2005 for federal agencies compared to their 1999 usage.
- Required U.S. federal fleets flex-fuel vehicles (FFVs) to operate on alternative fuels the majority of the time (51%) by 2005.

# Regulatory Drivers for Ethanol as a Fuel Continued-

## Energy Policy Act of 2005

- Extensive list of provisions to facilitate energy research and development.
- Related to alternative fuels for transportation:
  - Required 7.5 billion gallons of biofuel (mainly ethanol) must be mixed with gasoline sold in the U.S.
  - Authorized \$50 million annually over the life of the bill for a biomass grant program.
  - Financial incentives for hybrid vehicles.
  - Required U.S. Federal fleet FFVs to operate on alternative fuels 100% of the time.

## Executive Order 13423: Strengthening Federal Environmental, Energy, and Transportation Management. January 2007.

- Requires Federal agencies with 20 or more vehicles in U.S. to decrease petroleum consumption by 2% per year relative to their FY2005 baseline through 2015.
- Also requires agencies to increase alternative fuel use by 10% per year relative to the previous year.
- Revoked EO 13149.

# Regulatory Drivers for Ethanol as a Fuel Continued-

## **ENERGY INDEPENDENCE AND SECURITY ACT OF 2007 (EISA)**

➤ Increases the supply of alternative fuel sources by setting a mandatory Renewable Fuels Standards (RFS) for fuel producers:

36 billion gallons renewable fuels by 2022

21 billion gallons cellulosic based fuels by 2022

15 billion gallon cap for ethanol from corn by 2015

1 billion gallons biomass-based diesel by 2012

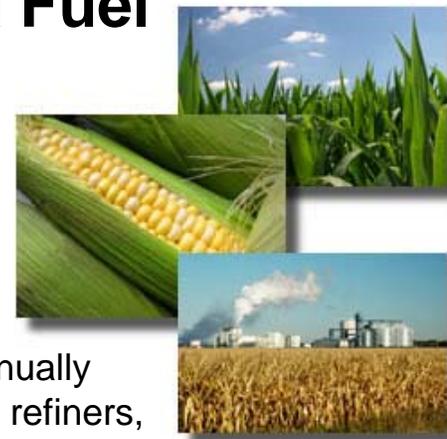
➤ Reduces U.S. demand for oil by setting a national fuel economy standard of 35 mpg by 2020 – which will increase fuel economy standards by 40%.

# Regulatory Drivers for Ethanol as a Fuel Continued-



## Renewable Fuel Standard Program

- Section 211(o) of the Clean Air Act, as amended by the Energy Independence and Security Act of 2007 (EISA) requires EPA to annually determine a renewable fuels standard (RFS) which is applicable to refiners, importers, and certain blenders of gasoline.
- On the basis of this standard, each obligated party determines the volume of renewable fuel that it must ensure is consumed as motor vehicle fuel.
- In EPA's February 14<sup>th</sup> FR notice, the RFS was set at 7.76% for 2008.
- The new mandate is intended to lead to the use of 9 billion gallons of renewable fuel in 2008. Estimates indicate it will require more than 22 million acres of corn to meet this requirement.
- EPA is struggling with how to implement the energy law mandate requiring fuel producers to ensure that biofuels emit at least 20% less greenhouse gas (GHG) emissions over their entire life cycle than conventional petroleum-based fuels in order to qualify for credits under the law's renewable fuel standard.



# Federal Tax Incentives for Ethanol

## **Biodiesel and Ethanol Federal Tax Credit (VEETC)**

- The American Jobs Creation Act of 2004 (Public Law 108-357) provides tax incentives to ethanol blenders/retailers of \$.51 per pure gallon of ethanol blended and \$1.00 per gallon of agri-biodiesel, but only \$.50 per gallon of waste-grease biodiesel

## **Alternative Fuel Infrastructure Federal Tax Credit**

- equal to 30% of the of cost alternative refueling property, up to \$30,000 for business property. Qualifying alternative fuels are natural gas, propane, hydrogen, E85, or biodiesel mixtures of B20 or more.

## **Small Producer Tax Credits**

**Small Ethanol Producer (up to 60 million gallons) -**  
a 10 cents per gallon production income tax credit on up to 15 million gallons of production annually.

The credit is capped at \$1.5 million per year per producer.

**Small Agri-Biodiesel Producer (up to 60 million gallons per year) -** allows a tax credit of 10 cents per gallon to small agri-biodiesel producers for up to 15 million gallons annually.

\$1.5 million per year per producer max.



Source: McGee, LDNR

# Current Status of Fuel Ethanol

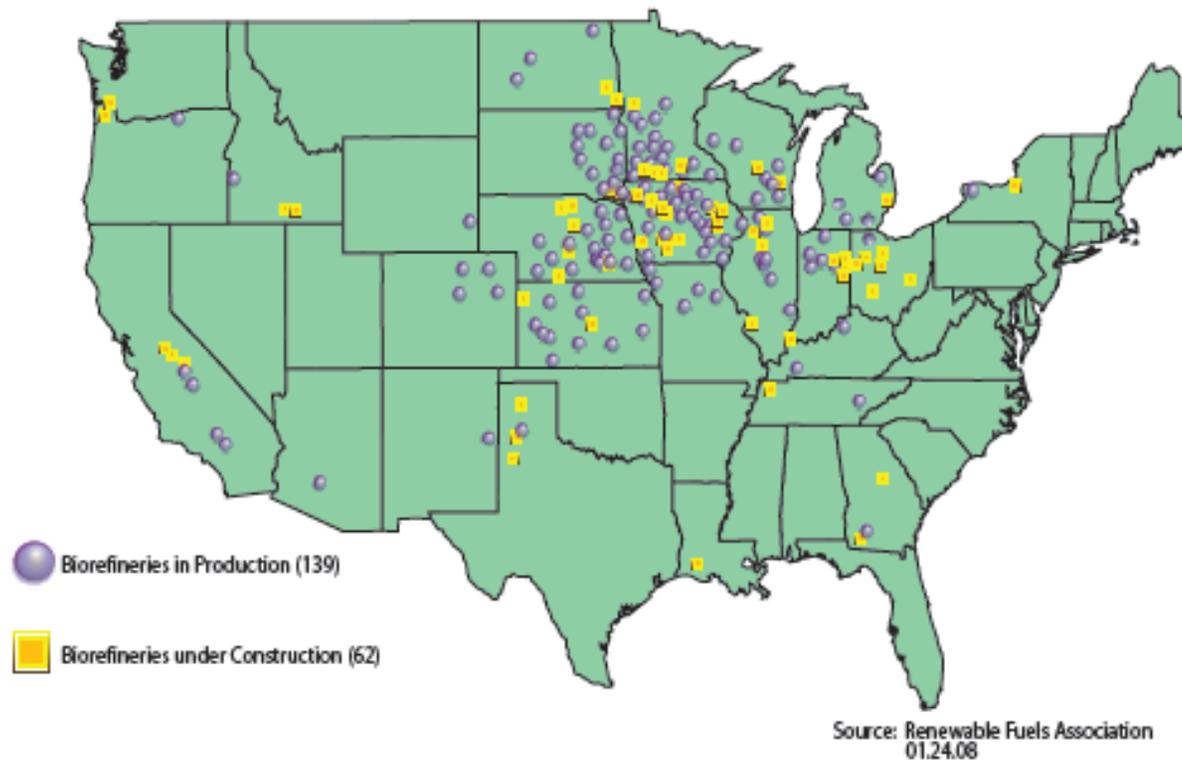
- Over 99 percent of the ethanol produced in the United States is mixed with gasoline to make E-10, the gas found at most public fuel pumps.
- About 50 percent of America's gasoline now includes some amount of ethanol. Source: American Petroleum Institute (API) <http://www.api.org/Newsroom/cavaney-renewable.cfm>
- Today over 6 million vehicles on U.S. roads are flexible fuel vehicles that can operate on E85 (a blend of 85% ethanol and 15% gasoline).
- St. Petersburg, Florida was the site of the greenest racing event in history April 5-6 when ethanol was featured in both the IndyCar Series Honda Grand Prix and the American Le Mans Series Acura Sports Car Challenge.



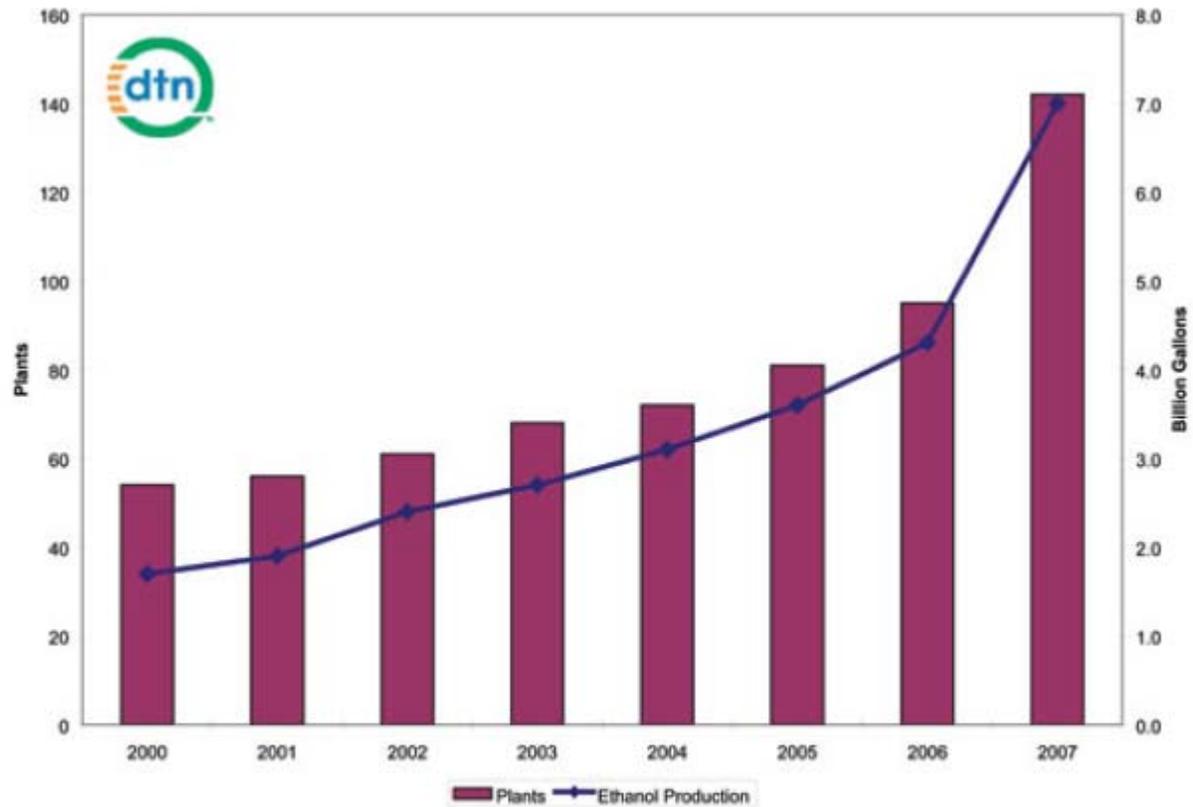
As of January 2008, E85 was available at approximately 1,300 locations throughout the United States. According to the AFDC, this number continues to grow.

# Current Status of Fuel Ethanol

## U.S. Ethanol Biorefineries Locations



# Current Status of Fuel Ethanol



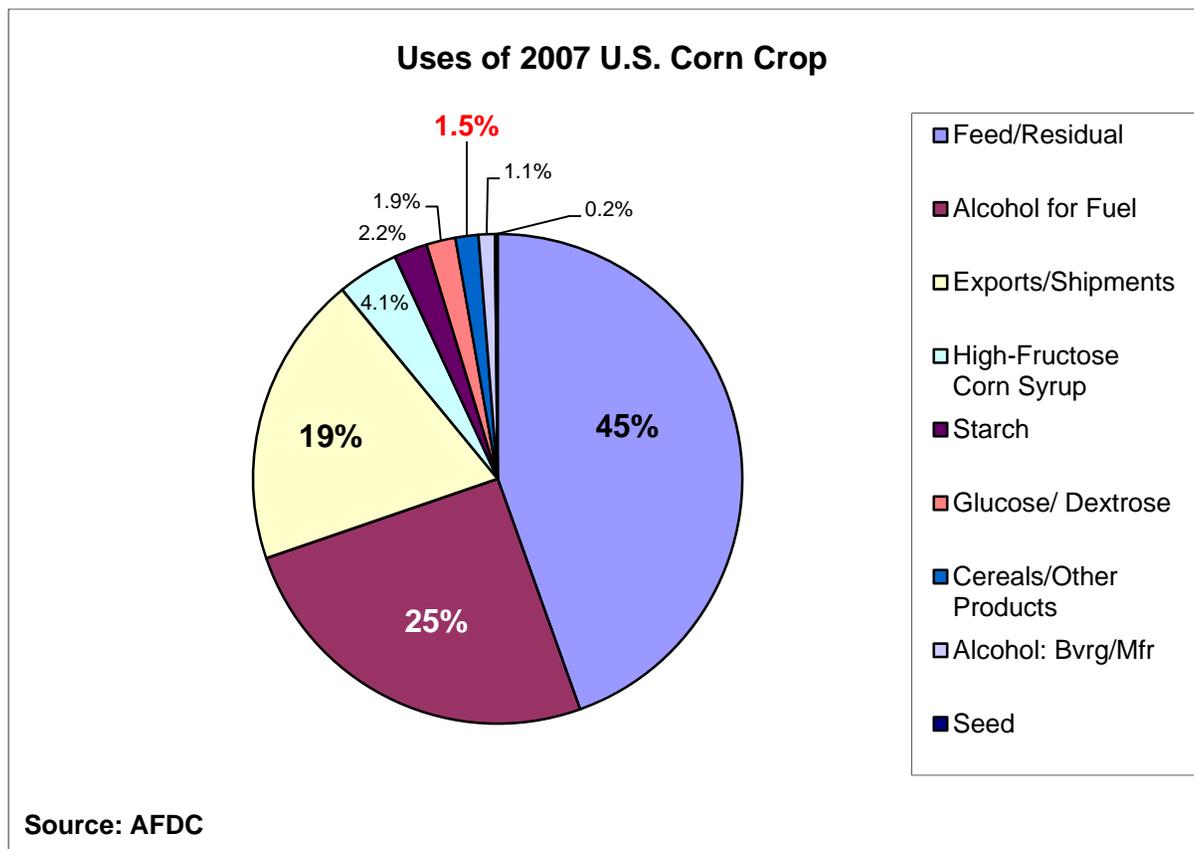
Source: "Ethanol Experiences Growing Pains," Ethanol Producer Magazine; December 2007.



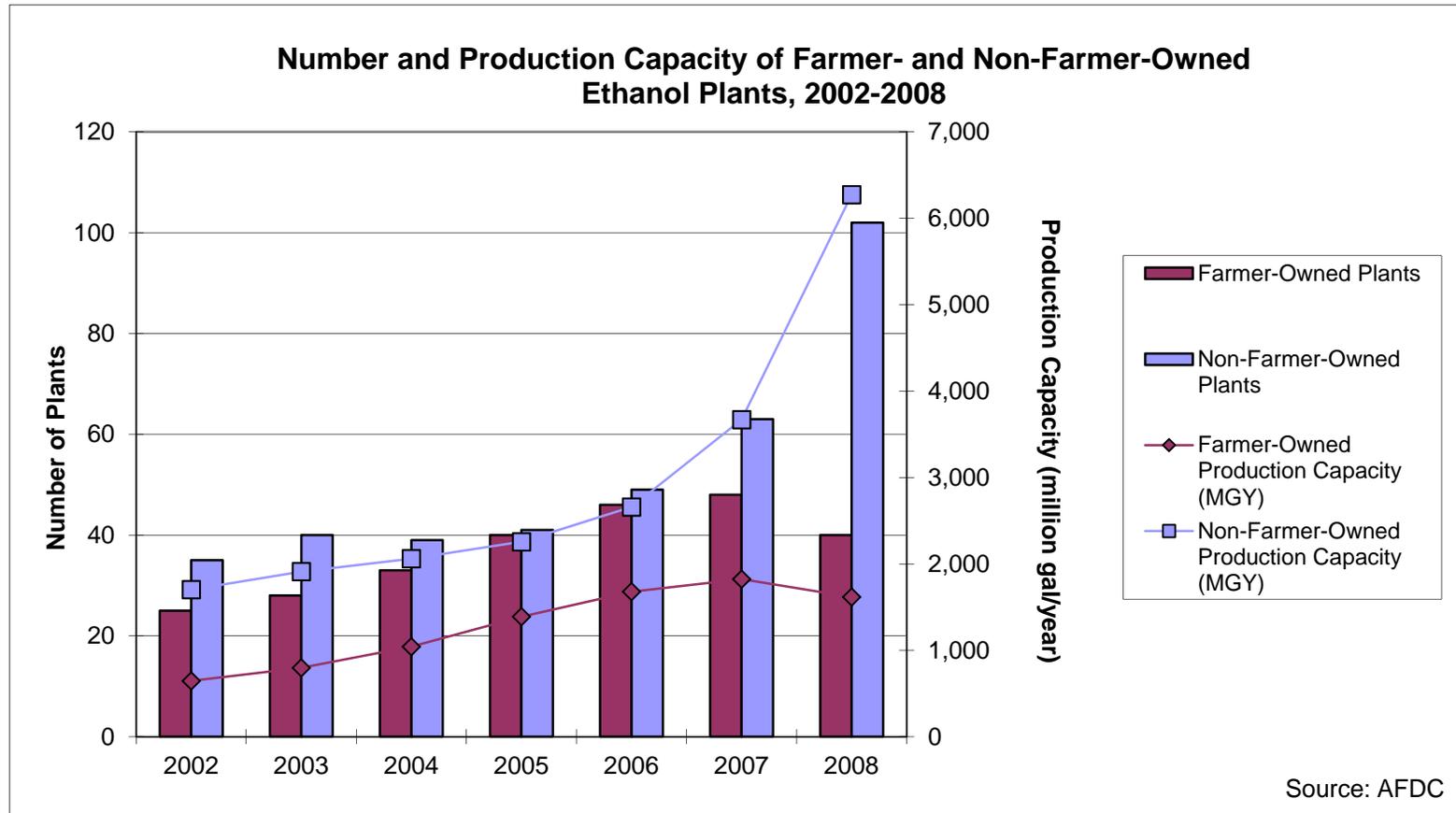
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# Current Status of Fuel Ethanol

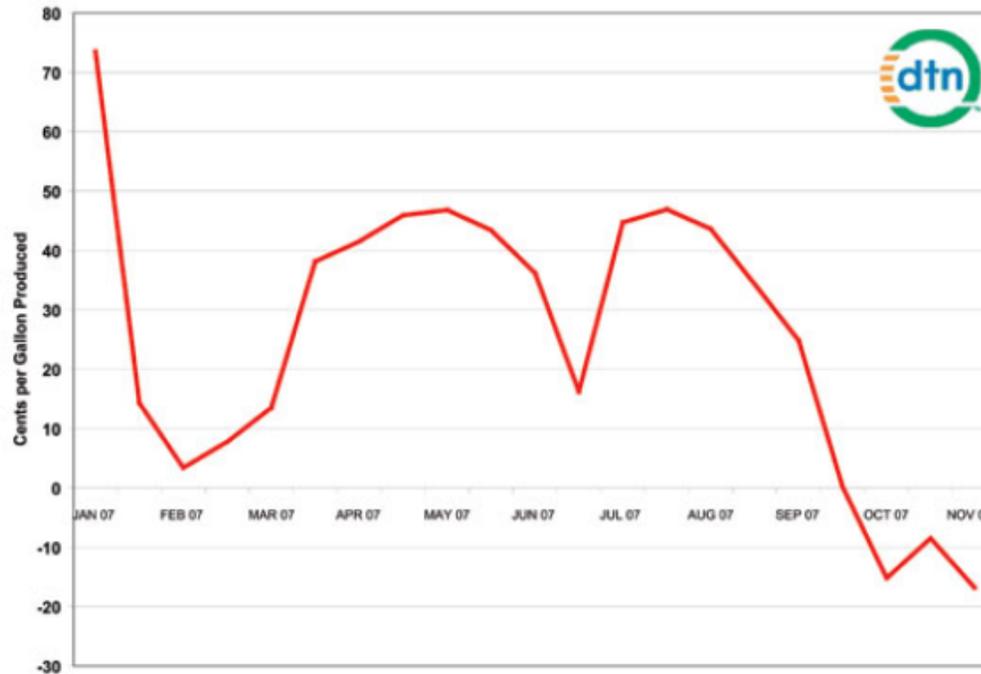


# Current Status of Fuel Ethanol



## Current Status and Prognosis for Alternative Fuels

### Ethanol Plant Net Profit



Source: "Ethanol Experiences Growing Pains," Ethanol Producer Magazine; December 2007.

# Contribution of the Ethanol Industry to the U.S. Economy in 2007

- The ethanol industry spent \$12.5 billion on raw materials, other inputs, and goods and services to produce an estimated 6.5 billion gallons of ethanol.
- An additional \$1.6 billion was spent to transport grain and other inputs to production facilities; ethanol from plants to terminals where it was blended with gasoline; and co-products to end-users.
- The largest share of this spending was for corn and other grains used as the raw material to produce ethanol. The ethanol industry used more than 2.4 billion bushels of corn in 2007, valued at \$8.1 billion.
- The remainder of the spending by the ethanol industry was for a wide range of inputs such as enzymes, yeast and chemicals; electricity, natural gas, and water; labor; and services such as maintenance, insurance, and general overhead.

# Corn Ethanol's Challenges

- Allegations that diversion of 25% of corn crop to produce ethanol resulted in increased food and animal feed costs
- An August 2007 UN report warns of “serious risks of creating a battle between food and fuel that will leave the poor and hungry in developing countries at the mercy of rapidly rising prices for food, land, and water”
- Research reported in *Science* that widespread use of ethanol from corn could result in nearly twice the greenhouse gas emissions as the gasoline it would replace because of expected land-use changes
- Ethanol is reported to contribute to smog and in several markets can be used only with a costlier base blend that compensates for this shortcoming
- Federal and state subsidies for ethanol in 2006 have been estimated to have been between \$5.1 and \$6.8 billion. They are projected to increase to as much as \$8.7 billion annually (International Institute for Sustainable Development)
- EPA seeks input on Texas Governor's RFS waiver request
- Farm Bill: Key farm-state lawmakers shifting support to cellulosic fuel
- Twenty-two Republican senators, including presidential candidate Senator John McCain of Arizona, sent a letter to the EPA suggesting it waive, or restructure, rules that require a five-fold increase in ethanol production over the next 15 years. (Morning Advocate 5-6-08)

# Corn Ethanol's Challenges

## Environmental Concerns for Biofuels

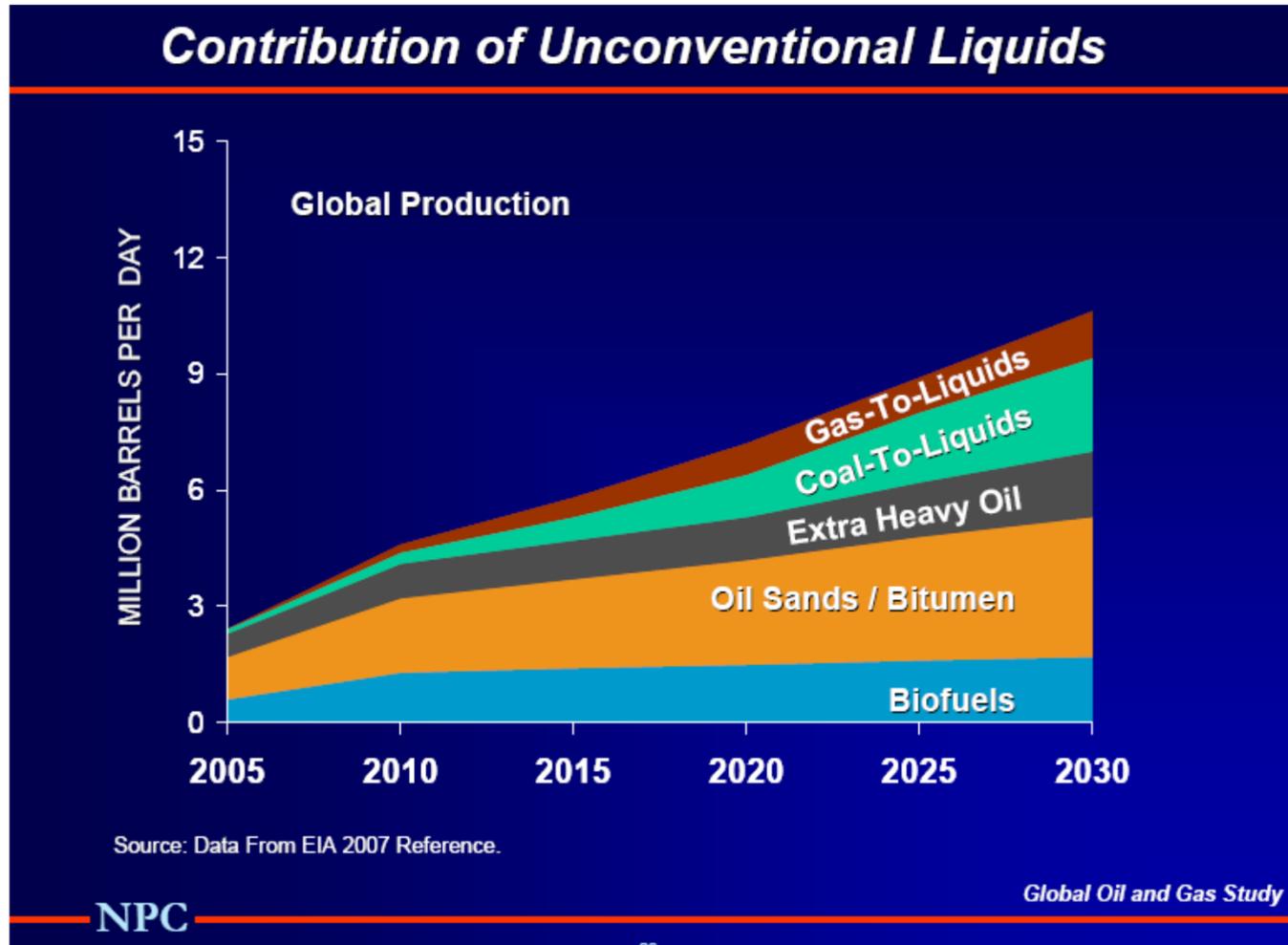
Fragione, J. 2008. Land Clearing and the **Biofuel Carbon Debt.**, *Science* online version. Planting corn on former cropland that has been idled through the Agriculture Department's Conservation Reserve Program causes a 48-year "carbon debt", while land conversions in Brazil, Indonesia, and Malaysia result in increased emissions that take from 17 to 423 years to work off through ethanol emissions savings.

Continuously-grown corn leads to heavy use of fertilizers, early return of land in conservation programs to production, and the conversion of marginal lands to high-intensity cropping. All of these bring with them well-known environmental problems associated with intensive farming: **persistent pest insects and weeds, pollution of groundwater, greater irrigation demands, less wildlife diversity, and the release of more carbon dioxide.** Carbon dioxide is a greenhouse gas that contributes to global climate change. Ironically, one of the touted benefits of biofuels is to help alleviate global climate change, a benefit that is considerably diluted under a high-intensity agriculture scenario. (Position statement - Ecological Society of America).

According to a recent study, increasing production of corn-based ethanol to meet alternative fuel goals may **worsen the "dead zone"** that plagues the Gulf of Mexico.

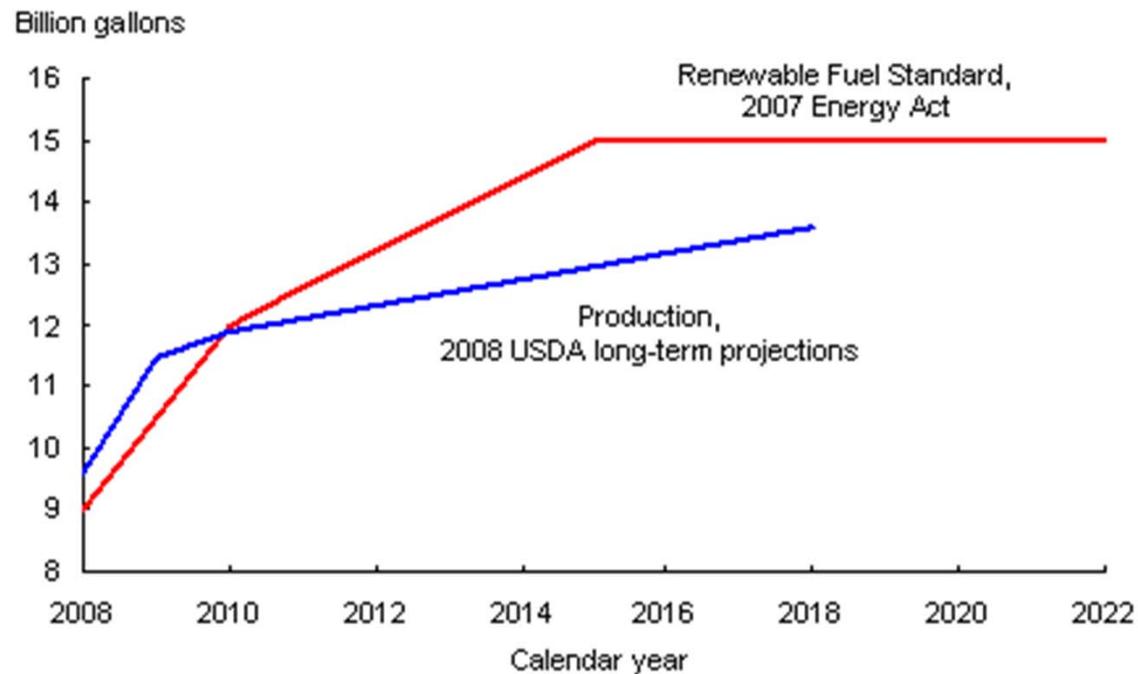


# Future of Fuel Ethanol



# Future of Fuel Ethanol

## Ethanol derived from corn starch

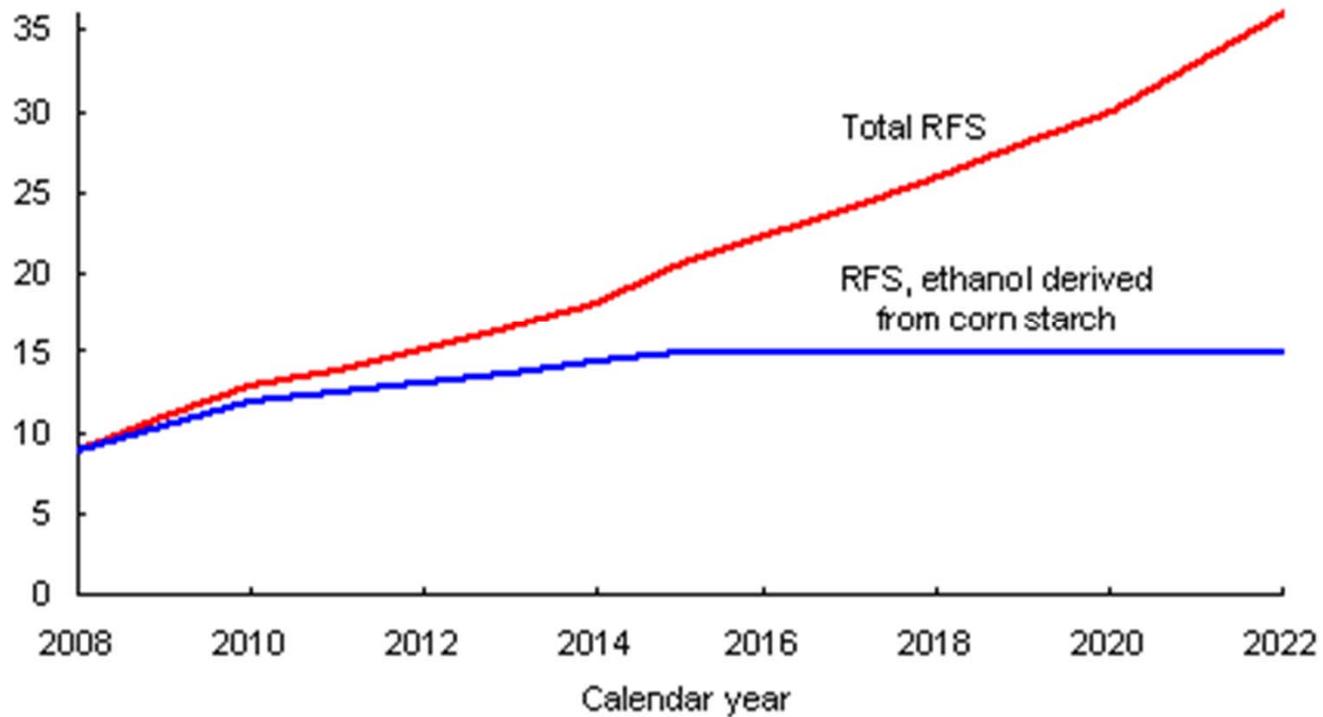


Source: *USDA Agricultural Projections to 2017*, February 2008.  
USDA, Economic Research Service.

# Future of Fuel Ethanol

## Renewable Fuel Standard, 2007 Energy Act

Billion gallons

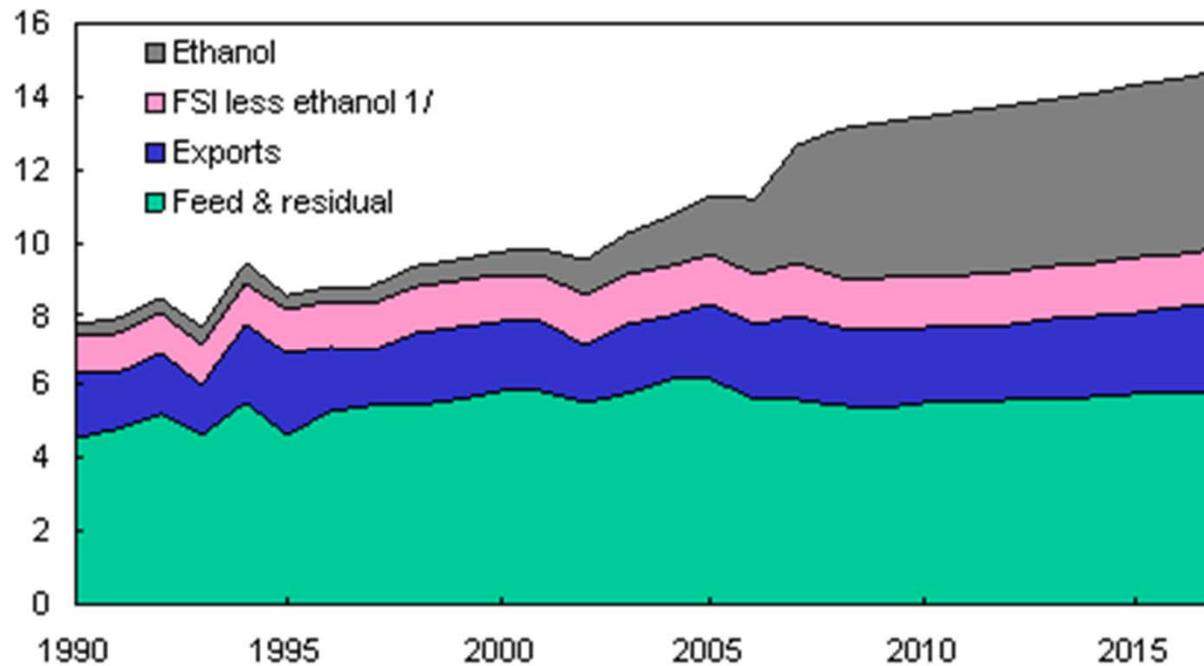


Source: *USDA Agricultural Projections to 2017*, February 2008.  
USDA, Economic Research Service.

# Future of Fuel Ethanol

## U.S. corn use

Billion bushels



1/ Food, seed, and industrial less ethanol.

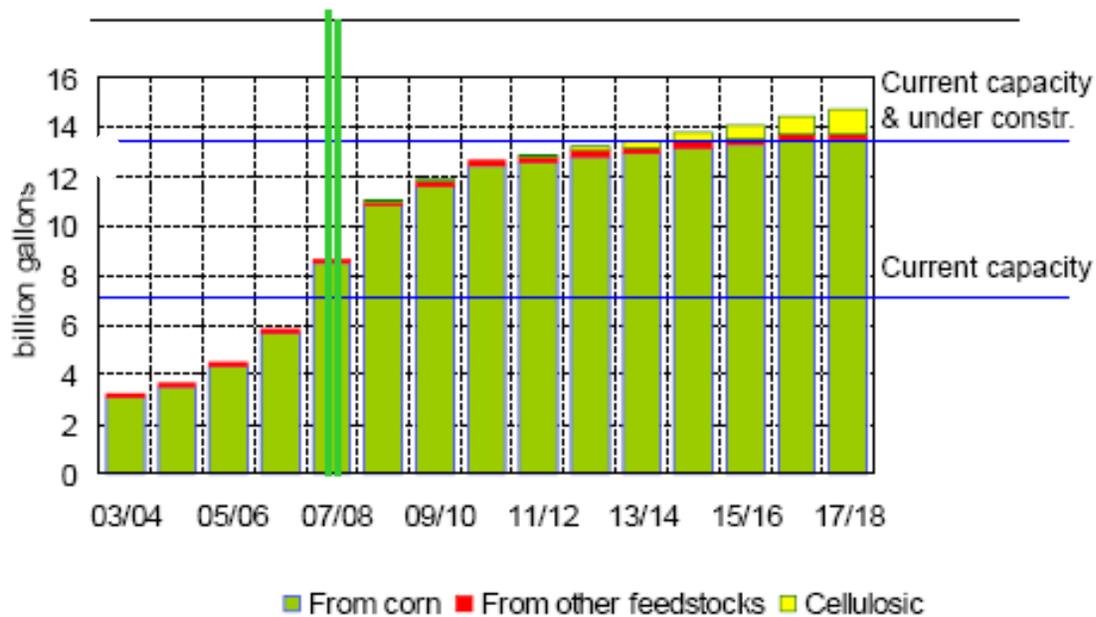
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# Future of Fuel Ethanol

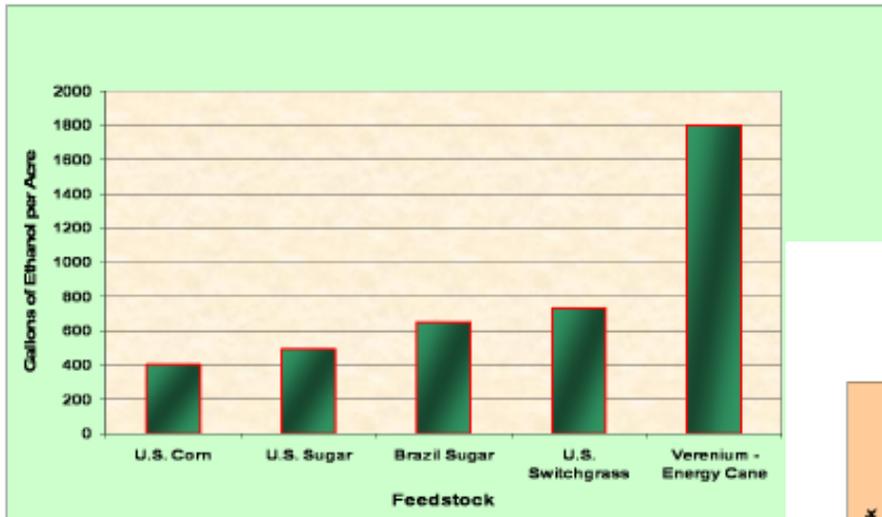
## Ethanol production



Current capacity and under construction from RFA as of Dec 3, 2007

# Future of Fuel Ethanol

## Ethanol Yield Comparison by Feedstock 30 Million Gallon per Year Project



## Crop Acreage Comparison by Feedstock 30 Million Gallon per Year Project



# Future of Fuel Ethanol

## How Large is the Opportunity?

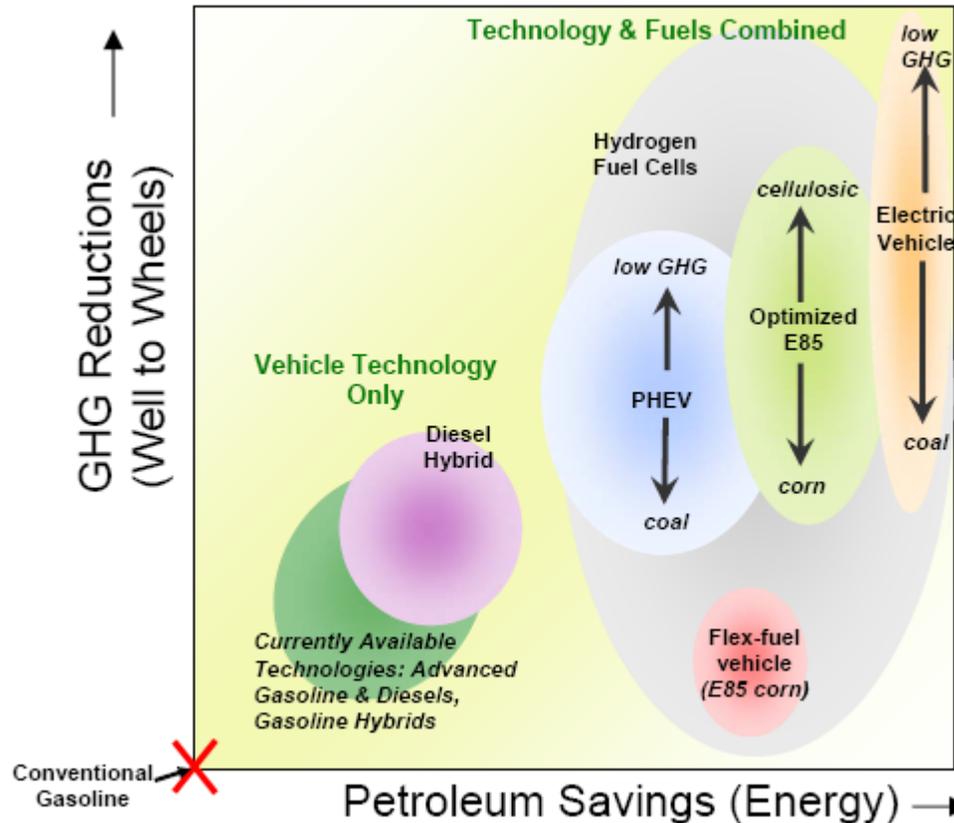
### Cellulosic Ethanol Production Requirements - 2022

- Number of Ethanol Plants: 700 (30 MGY each)
- Biomass Feedstock Required\*: 235 million dry tons
- Process Steam\*: 965 billion pounds
- Electricity Purchases\*: 66 million mWh
- Cost of Electricity\*: \$5.3 billion

\* Annual Basis



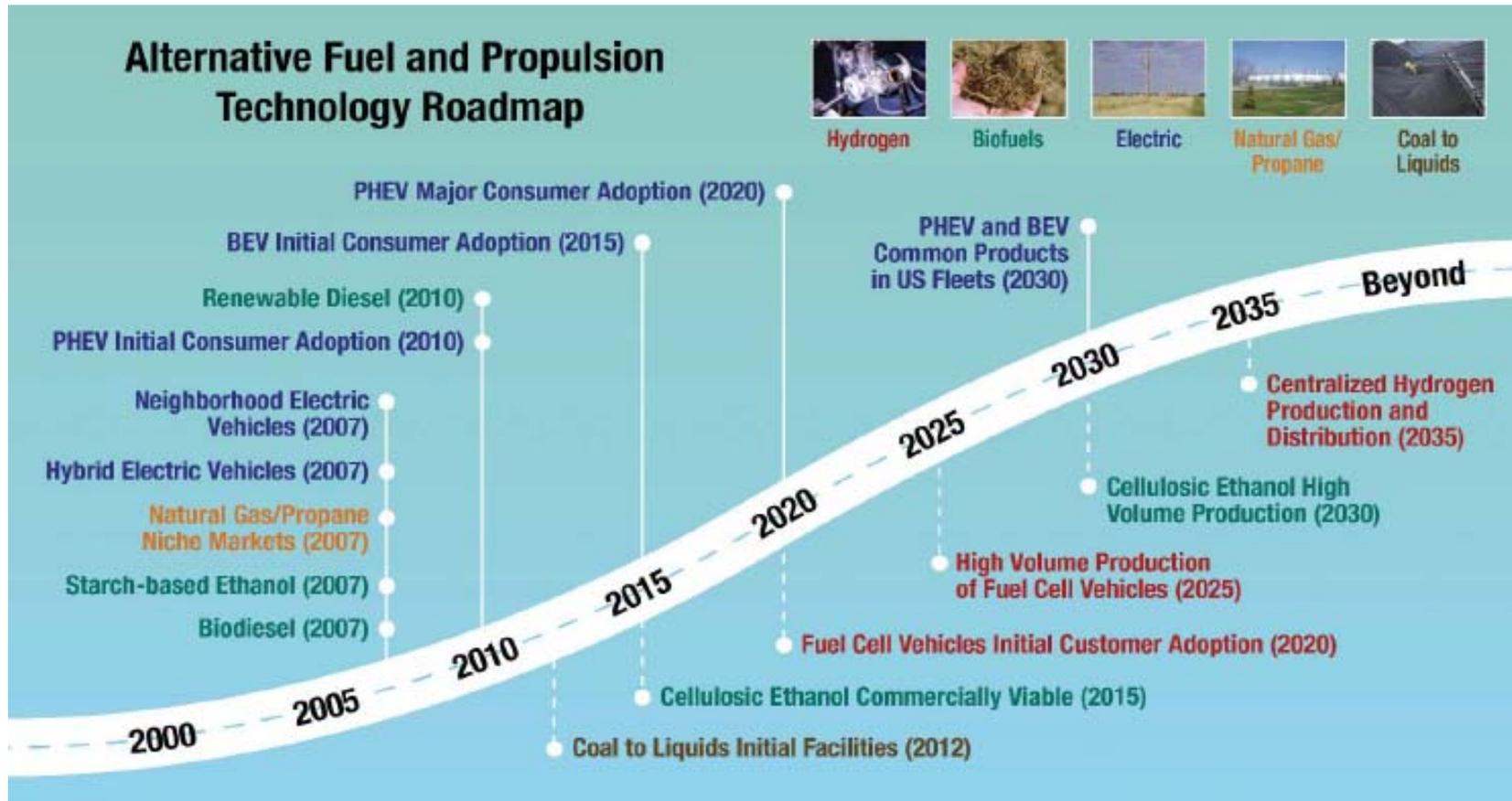
## Current Status and Prognosis for Alternative Fuels



Illustrative example of GHG reductions and petroleum savings for (1) various technology-only approaches and (2) combinations of vehicle technologies with alternative fuels. The reductions relative to today's conventional gasoline vehicle are shown. Note that the size and position of the bubbles are illustrative and assumptions-driven. Source: EPA



# Current Status and Prognosis for Alternative Fuels



Source: National Renewable Energy Laboratory

# THE FUTURE OF ETHANOL

## Questions/Discussion

