Ethanol Production, Distribution, and Use

Discussions on Key Issues

Rocky Mountain Fleet Managers Association
5-14-08

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Today's Topics

- Ethanol Basics
- Flexible Fuel Vehicles (FFVs)
- Energy Balance
- Supply and Price Impacts on Food
- Land Use
- Water Use
- Emissions
- Tools and Resources

Ethanol Production

2006 Capacity: 4.9 billion gal/year

(96.1% using natural gas as energy source with 2% coal, 1% coal and biomass, 1% syrup)

EPA, EPA420-D-06-008

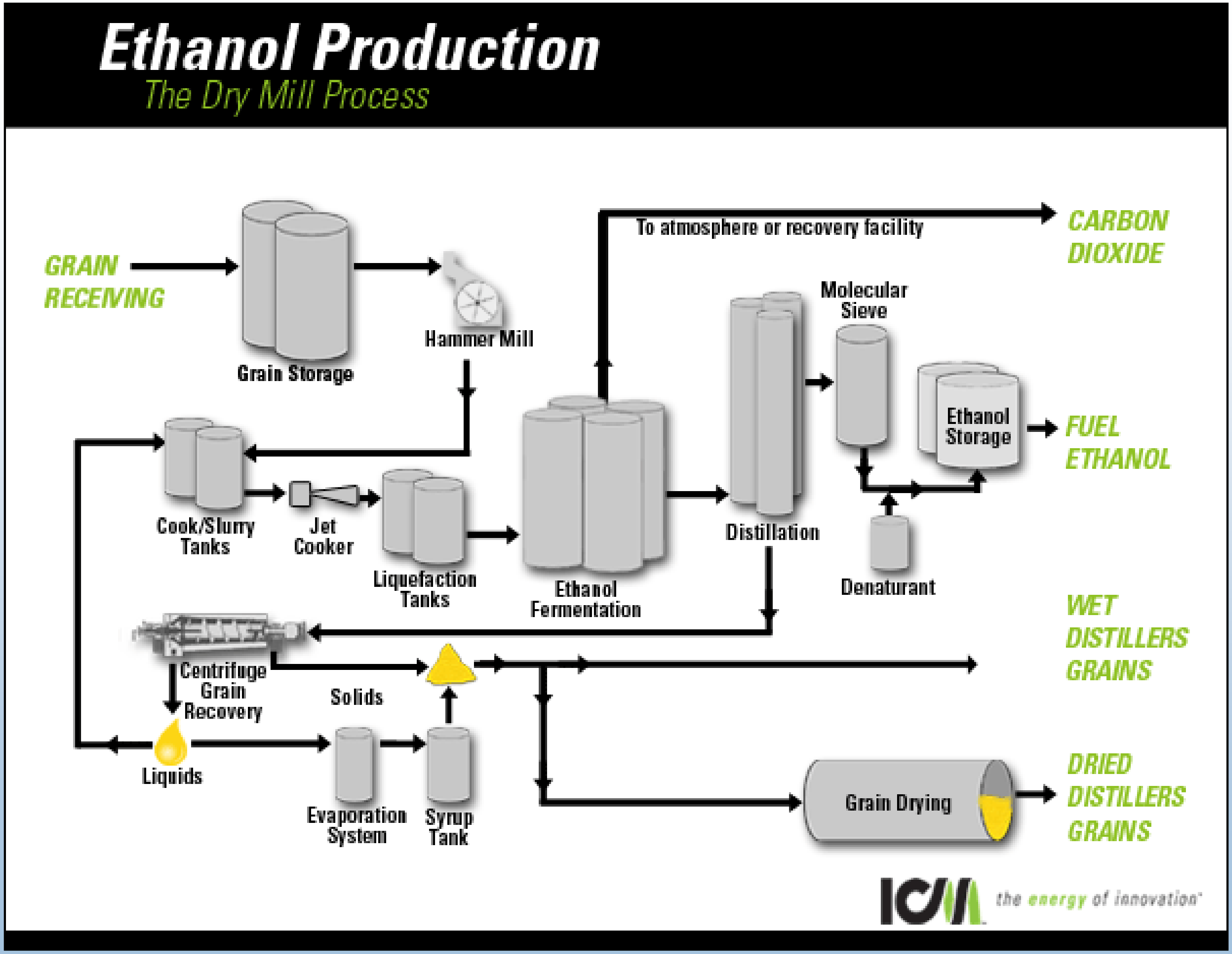
January 2008 Capacity: 7.9 billion gal/year

at 139 biorefineries RFA, 1/2008

Projected Future Production Capacity: 13.4 billion gal/year (online and under construction) RFA, 1/2008

Current Gasoline Usage: 141.8 billion gallons/year

or 388.6 million gal/day EIA, 7/2007

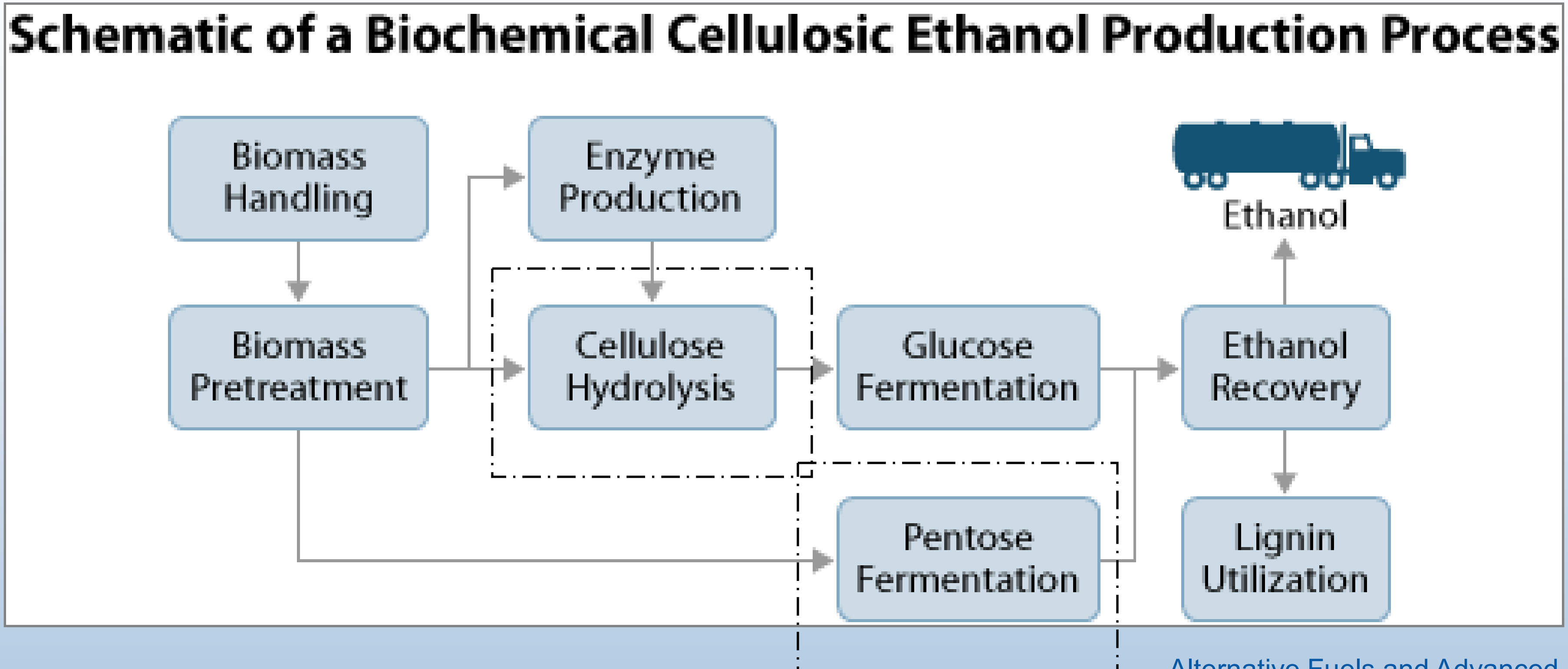

Ethanol Production
The Dry Mill Process
GRAIN RECEIVING
Grain Storage
Hammer Mill
To atmosphere or recovery facility
CARBON DIOXIDE
Molecular Sieve
Ethanol Storage
FUEL ETHANOL
Cook/Slurry Tanks
Jet Cooker
Liquefaction Tanks
Ethanol Fermentation
Distillation
Denaturant
WET DISTILLERS GRAINS
Centrifuge Grain Recovery
Solids
Liquids
Evaporation System
Syrup Tank
Grain Drying
DRIED DISTILLERS GRAINS
ICM the energy of innovation

Dry Mill Production Efficiencies 2001-2006

- **Ethanol Yield**: ↑ 6.4% per bushel
- **Total Energy Use**: ↓ 21.8%
- **Grid Electricity Use**: ↓ 15.7%
- **CO_2 Collection**: ↑ 23.5%
- **Consumptive Water Use**: ↓ 26.6%

Analysis of the Efficiency for the U.S. Ethanol Industry 2007, Argonne National Laboratory, 3/2008

Cellulosic Ethanol Production



Alternative Fuels and Advanced Vehicles Data Center

Recent Awards

$4.1 million, USDA, woody biomass development

$18.4 million over three years; DOE/USDA; biomass research, development and demonstration projects

$33.8 million over four years, DOE, further development of commercially viable renewable fuels

Up to $86 million over four years, DOE, support development of small scale cellulosic biorefineries

Ethanol Fuels

- **E10:** Uses existing vehicles and infrastructure
- **E85:** Used in FFVs and requires specialized infrastructure
- **E15-E20:** Not a legal fuel except for use in FFVs. Currently being explored for non-FFVs

How are FFVs different?

Engine calibration updates: Fueling and spark advance calibrations directed by vehicle computer and software to optimize combustion, enable cold start, and meet emissions requirements

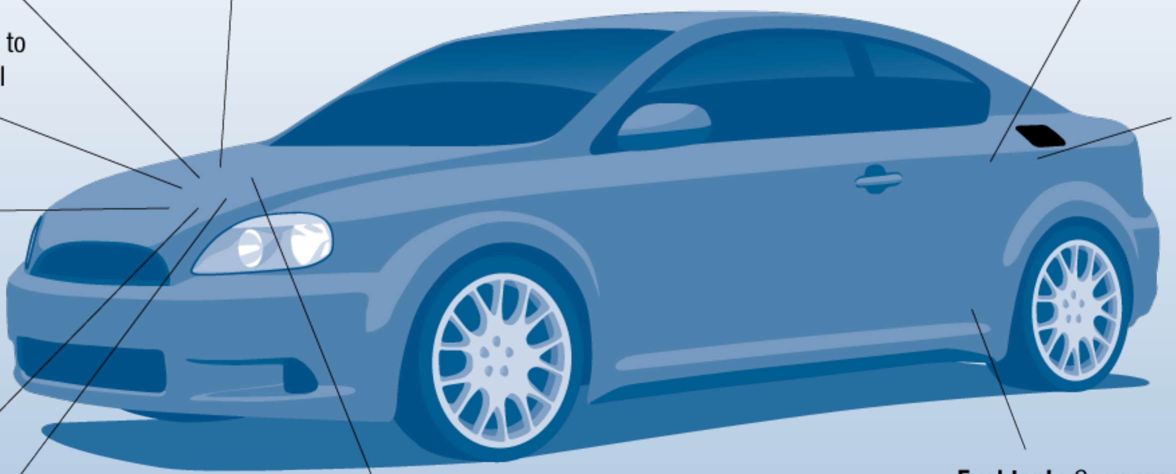
Insulated wiring: Made from special materials to handle ethanol's increased conductivity and corrosiveness

Fuel pump assembly: In-tank components made from ethanol-compatible materials; larger capacity fuel pump to deliver more fuel to compensate for ethanol's lower energy density

Piston rings: Special materials used to minimize wear from ethanol's alcohol properties, which wash lubrication from parts

Fuel filler neck: Anti-siphon and spark arrestor features included to meet U.S. regulations

Cylinder heads, valve seats, and valves: Special materials used to minimize wear from ethanol's alcohol properties, which wash lubrication from parts



Fuel sensor: Automatically senses the composition of fuel to adjust for ethanol blends

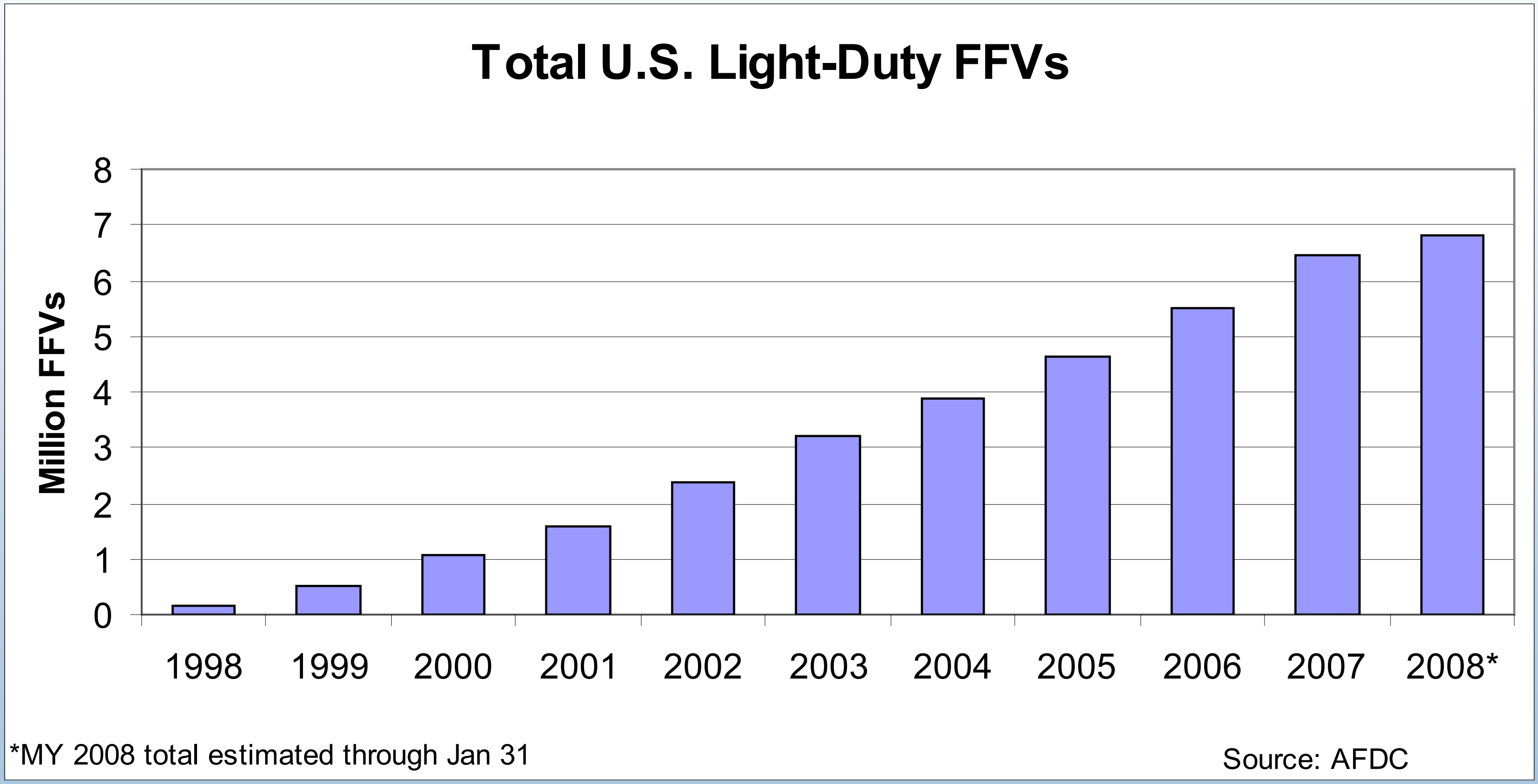
Fuel tank: Composed of special materials to minimize evaporative emissions from ethanol

Fuel injectors: Made from ethanol-compatible materials; designed to deliver greater fuel volume required by ethanol's lower energy density

Fuel rail and fuel lines: Made from ethanol-compatible materials; designed to handle increased fuel volume requirements to compensate for ethanol's lower energy density

www.eere.energy.gov/afdc/pdfs/42953.pdf

Current FFV Population



There are currently more than 6 million FFVs on U.S. roads.

2008 MY FFV Availability

Model Year 2008: Alternative Fuel Vehicles and Advanced Technology Vehicles

Fuel Type	Model	Vehicle Type	EPAct Compliant	Emission Class	Powertrain	Fuel Economy[1,2] (Alternative Fuel)	Fuel Economy[1,2] (Gasoline)
American Honda Motor Corporation 888-CC-HONDA / www.honda.com							
CNG Dedicated	Civic GX	Compact Sedan	Yes	ILEV, AT-PZEV, Tier-2 Bin 2	1.8L V4	24/36 mpgge	N/A
HEV (NiMH)	Civic Hybrid	Compact Sedan	No	SULEV, AT-PZEV	1.3L CVT V4	N/A	40/45
Hydrogen Fuel Cell	FCX[3]	Compact Sedan	Yes	ZEV, Tier-2 Bin 1	107 hp AC synchronous electric motor	62/51 mpkg	N/A
Chrysler 800-999-FLEET / www.fleet.chrysler.com							
E85 FFV	Chrysler Sebring	Sedan	Yes	LEV II, Tier-2 Bin 8A	2.7L V6	13/20	18/27
E85 FFV	Dodge Avenger SXT	Sedan	Yes	ULEV	2.7L V6	13/19	18/26
E85 FFV	Chrysler Aspen[4]	SUV	Yes	LEV II, Tier-2 Bin 8A	4.7L V8	9/12	14/19
E85 FFV	Dodge Durango[4]	SUV	Yes	LEV II, Tier-2 Bin 8A	4.7L V8	9/12	14/19
E85 FFV	Dodge Dakota[4]	Light-Duty Pickup	Yes	LEV II, Tier-2 Bin 8A	4.7L V8	12/16	14/19
E85 FFV	Dodge Ram 1500[4]	Light-Duty Pickup	Yes	LEV II, Tier-2 Bin 8A	4.7L V8	12/16	13/17
E85 FFV	Chrysler Town & Country Dodge Grand Caravan	Minivan	Yes	ULEV, Tier-2 Bin 8A	3.3L V6	11/17	17/24
E85 FFV	Jeep Commander[4]	SUV	Yes	LEV II, Tier-2 Bin 10A	4.7L V8	9/13	14/19
E85 FFV	Jeep Grand Cherokee[4]	SUV	Yes	LEV II, Tier-2 Bin 10A	4.7L V8	9/13	14/19
Ford Motor Company 800-34-FLEET / www.fleet.ford.com www.fordvehicles.com							
E85 FFV	Crown Victoria Crown Victoria Police[3]	Sedan	Yes	LEV II, Tier-2 Bin 5	4.6L V8	11/16	15/23
E85 FFV	Lincoln Town Car[3,4] Mercury Grand Marquis	Sedan	Yes	LEV II, Tier-2 Bin 5	4.6L V8	11/16	15/23
E85 FFV	F-150	Light-Duty Pickup	Yes	LEV, Tier-2 Bin 8A	5.4L V8	10/13	13/18
HEV (NiMH)	Escape Hybrid	SUV	No	SULEV II, AT-PZEV	2.3L ECVT V4	N/A	34/30
HEV (NiMH)	Mercury Mariner Hybrid	SUV	No	SULEV II, AT-PZEV	2.3L ECVT V4	N/A	34/30
LPG	F-150 LPI	Light-Duty Pickup	Yes	TBD	5.4L V8	TBD	N/A
General Motors Corporation 888-GM-AFT-4U / www.gmaltfuel.com							
E85 FFV	Chevrolet Impala Chevrolet Impala Police[3]	Sedan	Yes	LEV II, Tier-2 Bin 5	3.5L V6 3.9L V6	14/21	18/29
E85 FFV	Chevrolet Tahoe Chevrolet Tahoe Police[3] GMC Yukon	SUV	Yes	LEV II, Tier-2 Bin 5	5.3L V8	11/15	14/20
E85 FFV	Chevrolet Suburban GMC Yukon XL	SUV	Yes	LEV II, Tier-2 Bin 5	5.3L V8	11/15	14/20
E85 FFV	Chevrolet Avalanche	Light-Duty Pickup	Yes	LEV II, Tier-2 Bin 5	5.3L V8	11/15	14/20
E85 FFV	Chevrolet Silverado GMC Sierra	Light-Duty Pickup	Yes	LEV II, Tier-2 Bin 5	5.3L V8	11/15	15/20
E85 FFV	Chevrolet Express GMC Savana	Light-Duty Van	Yes	LEV II, Tier-2 Bin 5	5.3L V8	9/12	12/16
E85 FFV	Chevrolet Uplander	Light-Duty Van	Yes	LEV II, Tier-2 Bin 5	3.9L V6	12/17	16/23
HEV (NiMH)	Chevrolet Malibu	Sedan	No	LEV II, Tier-2 Bin 5	2.4L Ecotec V4	N/A	24/32
HEV (NiMH)	Saturn Aura	Sedan	No	LEV II, Tier-2 Bin 5	2.4L Ecotec V4	N/A	24/32
HEV (NiMH)	Chevrolet Tahoe GMC Yukon	SUV	No	LEV II, Tier-2 Bin 5	6.0L Vortec V8	N/A	20/21
HEV (NiMH)	Saturn VUE Green Line	SUV	No	LEV II, Tier-2 Bin 5	2.4L V4	N/A	27/32

- 22 models available from five manufacturers
- Light-duty cars to full-size pickups and SUVs

Fuel Type	Model	Vehicle Type	EPAct Compliant	Emission Class	Powertrain	Fuel Economy[1,2] (Alternative Fuel)	Fuel Economy[1,2] (Gasoline)
Lexus 800-255-3987 / www.lexus.com							
HEV (NiMH)	Lexus GS 450h	Sedan	No	SULEV	3.5L ECVT V6	N/A	22/25
HEV (NiMH)	Lexus RX 400h	SUV	No	SULEV	3.3L ECVT V6	N/A	27/24
HEV (NiMH)	Lexus LS 600h	Sedan	No	SULEV	5.0L ECVT V8	N/A	20/22
Mazda 800-222-5500 / www.mazdausa.com							
HEV (NiMH)	Tribute[5]	SUV	No	SULEV II, AT-PZEV	2.3L ECVT V4	N/A	34/30
Mercedes-Benz USA[6] 800-FOR-MERCEDES / www.mbusa.com							
E85 FFV	C300 Sport Sedan	Sedan	Yes	ULEV	3.0L V6	13/19	18/25
Nissan USA[6] 800-NISSAN-1 / www.nissanusa.com							
E85 FFV	Armada[7]	SUV	Yes	LEV	5.6L V8	9/13	12/18
E85 FFV	Titan[7]	Light-Duty Pickup	Yes	LEV	5.6L V8	9/13	12/17
HEV (NiMH)	Altima[8]	Sedan	No	AT-PZEV	2.5L ECVT V4	N/A	35/33
Toyota Motor Sales, USA 800-331-4331 / www.toyota.com							
HEV (NiMH)	Prius	Mid-Size	No	SULEV, AT-PZEV, Tier 2 Bin 3	1.5L ECVT V4	N/A	48/45
HEV (NiMH)	Camry	Sedan	No	AT-PZEV	2.4L ECVT V4	N/A	33/34
HEV (NiMH)	Highlander	SUV	No	SULEV, Tier-2 Bin 3	3.3L ECVT V6	N/A	27/25

[1] Fuel economy estimates were obtained from the EPA; please review specific manufacturer Web sites for other mileage estimates.
[2] Fuel economy estimates are provided for city/highway driving in miles per gallon, unless otherwise noted.
[3] This vehicle is only available to fleet customers.
[4] This FFV model is not available in California, Connecticut, Maine, Massachusetts, Pennsylvania, New Jersey, New York, Rhode Island, and Vermont.
[5] This HEV model is only available in select areas of California.
[6] Specifications have not been confirmed by this manufacturer for the 2008 model year.
[7] This FFV model is not available in California, Maine, Massachusetts, New York, or Vermont.
[8] This HEV model is only available in California, Connecticut, Maine, Massachusetts, New Jersey, New York, Rhode Island, and Vermont.

Glossary of Abbreviations

AT-PZEV = Advanced Technology Partial Zero Emissions Vehicle
CNG = Compressed Natural Gas
E85 = 85% Ethanol, 15% Gasoline
ECVT = Electronically controlled Continuously Variable Transmission
EPA = U.S. Environmental Protection Agency
FFV = Flexible Fuel Vehicle (E85 compatible)
HEV = Hybrid Electric Vehicle
ILEV = Inherently Low Emission Vehicle
L = Liter
LEV = Low Emission Vehicle
mpgge = miles per gasoline gallon equivalent
mpkg = miles per kilogram of hydrogen
NiMH = Nickel Metal Hydride
PZEV = Partial Zero Emissions Vehicle
SULEV = Super Ultra Low Emission Vehicle
SUV = Sport Utility Vehicle
TBD = To Be Determined
ULEV = Ultra Low Emission Vehicle
U.S. DOE = United States Department of Energy
ZEV = Zero Emission Vehicle

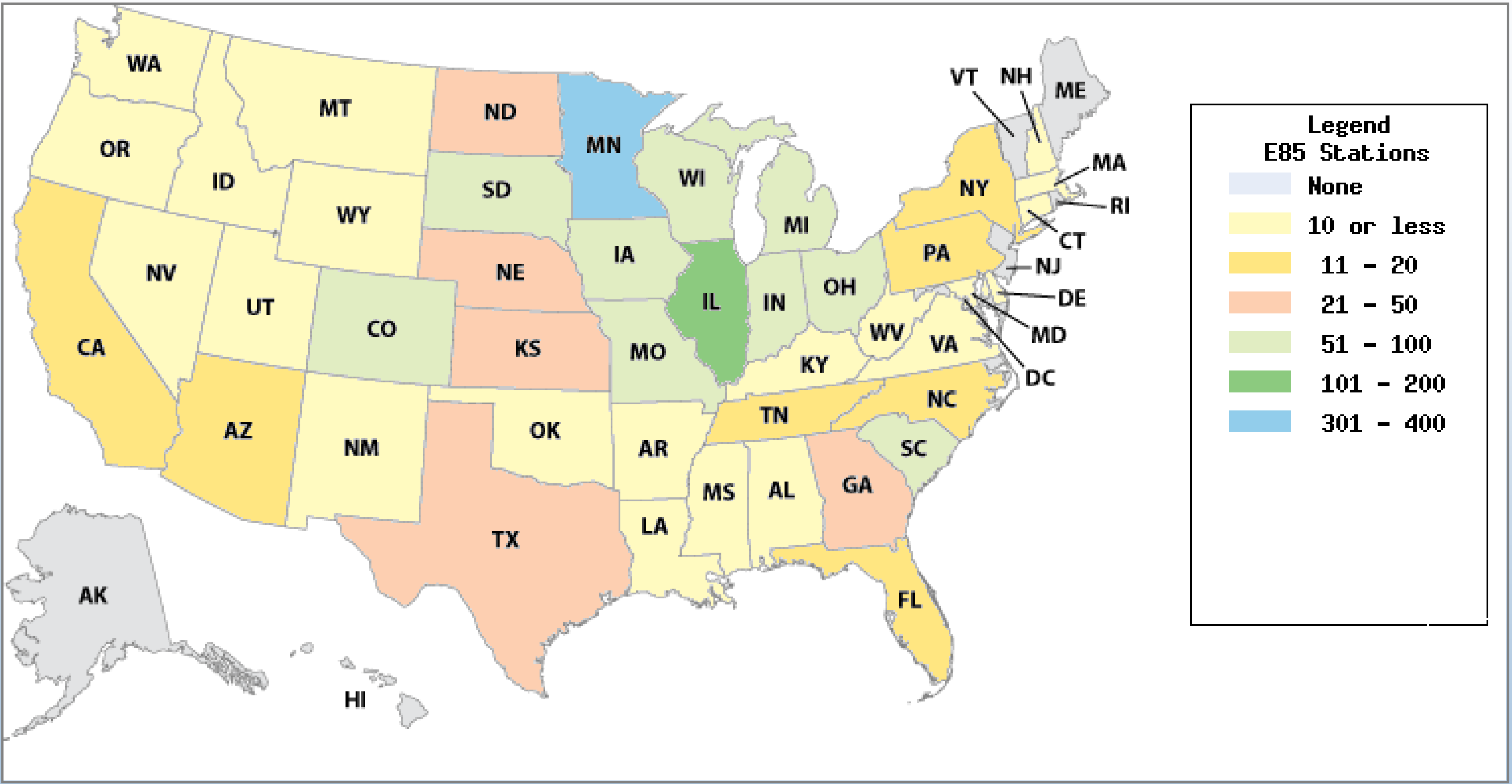
Other Resources

Alternative Fuel Fleet Applications www.eere.energy.gov/afdc/fleets/index.html
U.S. DOE Clean Cities www.eere.energy.gov/cleancities
Fuel Economy Guide www.fueleconomy.gov
Alternative Fuels & Advanced Vehicles Data Center www.eere.energy.gov/afdc

National Renewable Energy Laboratory supporting DOE's Clean Cities Program October 2007

www.eere.energy.gov/afdc/pdfs/my2008_afv_atv.pdf

Existing E85 Infrastructure



www.eere.energy.gov/afdc/ethanol/ethanol_locations.html

There were 1,444 total E85 stations as of May 13, 2008.

Infrastructure Considerations

- There is currently no UL-certified dispensing equipment.
- Most jurisdictions allow alternate equivalent dispenser designs to be submitted for approval. Each jurisdiction has its own process and discretion in granting variances or waivers to approve designs not UL-certified.
- Firefighting technique is different. First responders must use alcohol-resistant foams.
- Federal and state incentives are available for alternative fuel infrastructure.

Do you get decreased fuel economy?

- E85 has 72%-77% of the energy content of gasoline (116,090 BTU/gallons for gasoline vs. 76,330 BTU/gallons for 100% ethanol). www.eere.energy.gov/afdc/fuels/properties.html
  - You would expect 23%-28% decrease in fuel economy from energy content difference
- FuelEconomy.gov shows FFV mpg ratings are 20%-36% lower for city and 20%-32% lower for highway than non conventional vehicles.
  - Fuel economy impact is model-dependent but shows decreases
- Ethanol's lower energy content by volume means more fuel is needed to get the same power. Power is limited by the volume of the fuel/air mixture that the cylinder can handle.

Does higher octane mean more power?

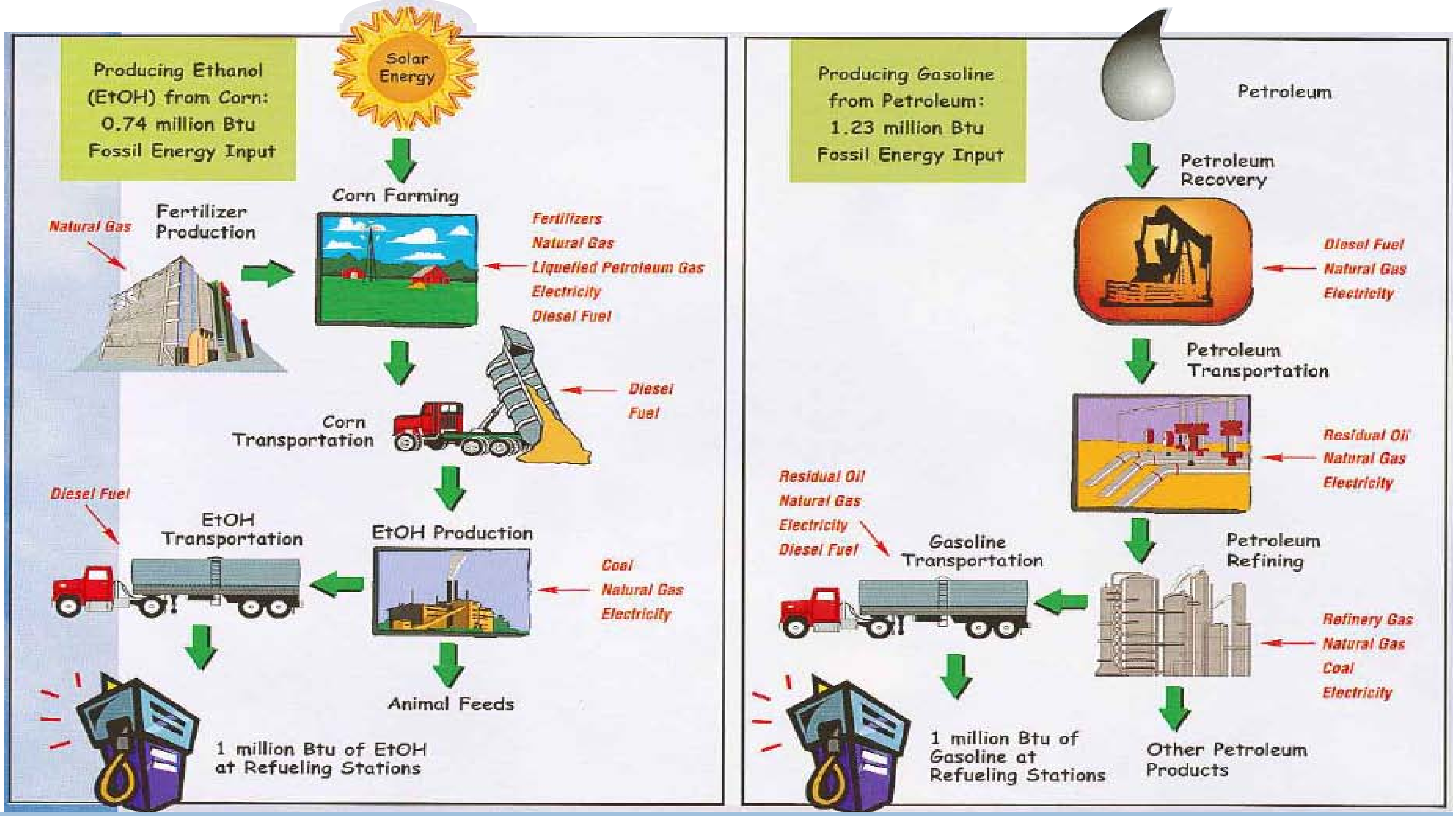
- Octane is a measure of auto ignition (detonation) resistance and is sometimes referred to as knock resistance
- Higher octane is beneficial in spark ignition engines designed for the higher octane
  - Increased combustion chamber compression
  - Supercharged or turbocharged
  - Bigger displacement
- Not a measure of deflagration (burn) or energy content

Ethanol Energy Balance

Most studies conclude that there is a net positive gain in life cycle energy when ethanol is produced from corn.

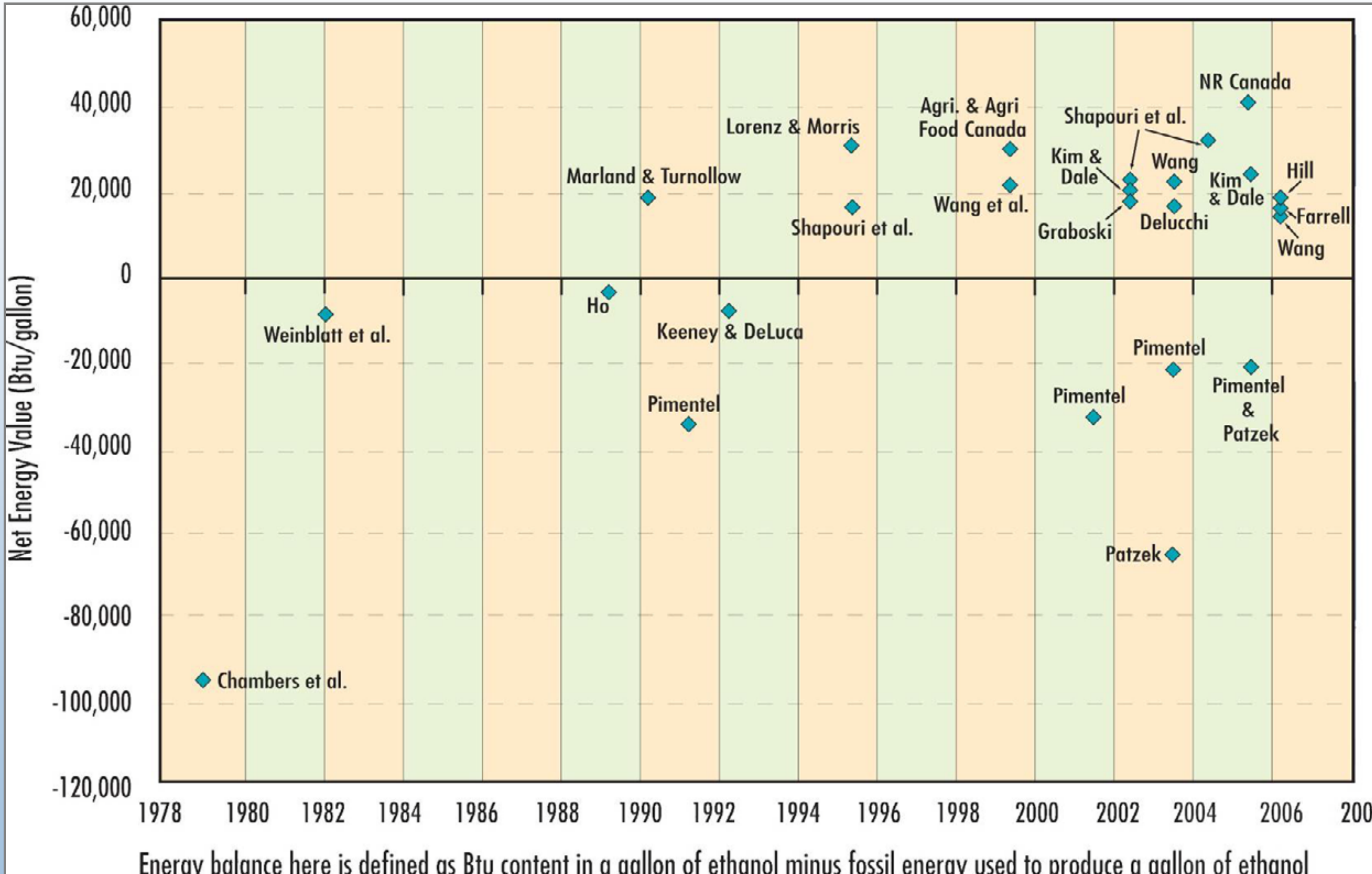
The amount of gain is greater when a cellulosic feedstock is used.

Ethanol Energy Balance



ANL, Ethanol, the complete energy lifecycle picture, 3/2007

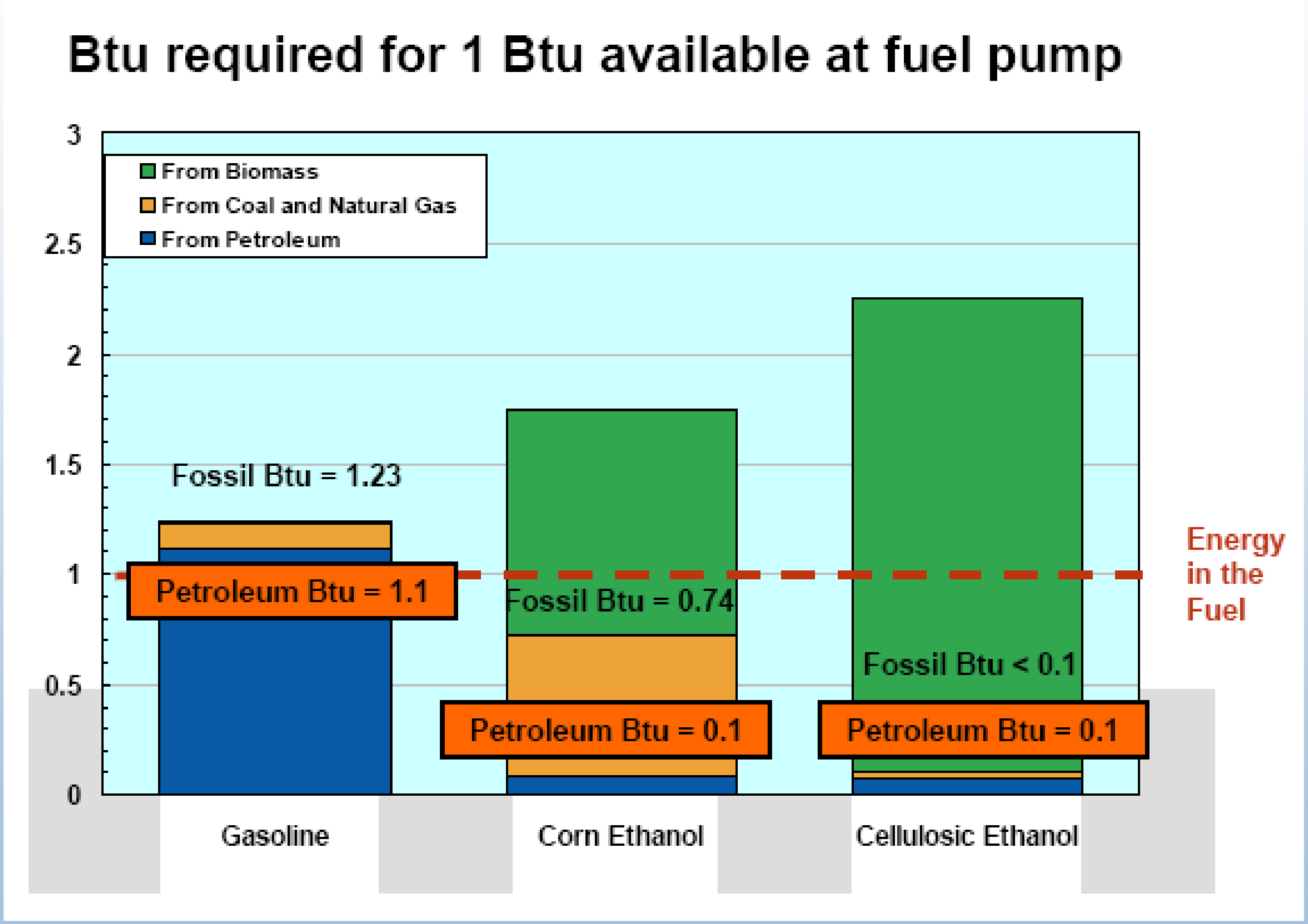
Ethanol Energy Balance for Corn Ethanol



ANL, Ethanol, the complete energy lifecycle picture, 3/2007

National Renewable Energy Laboratory

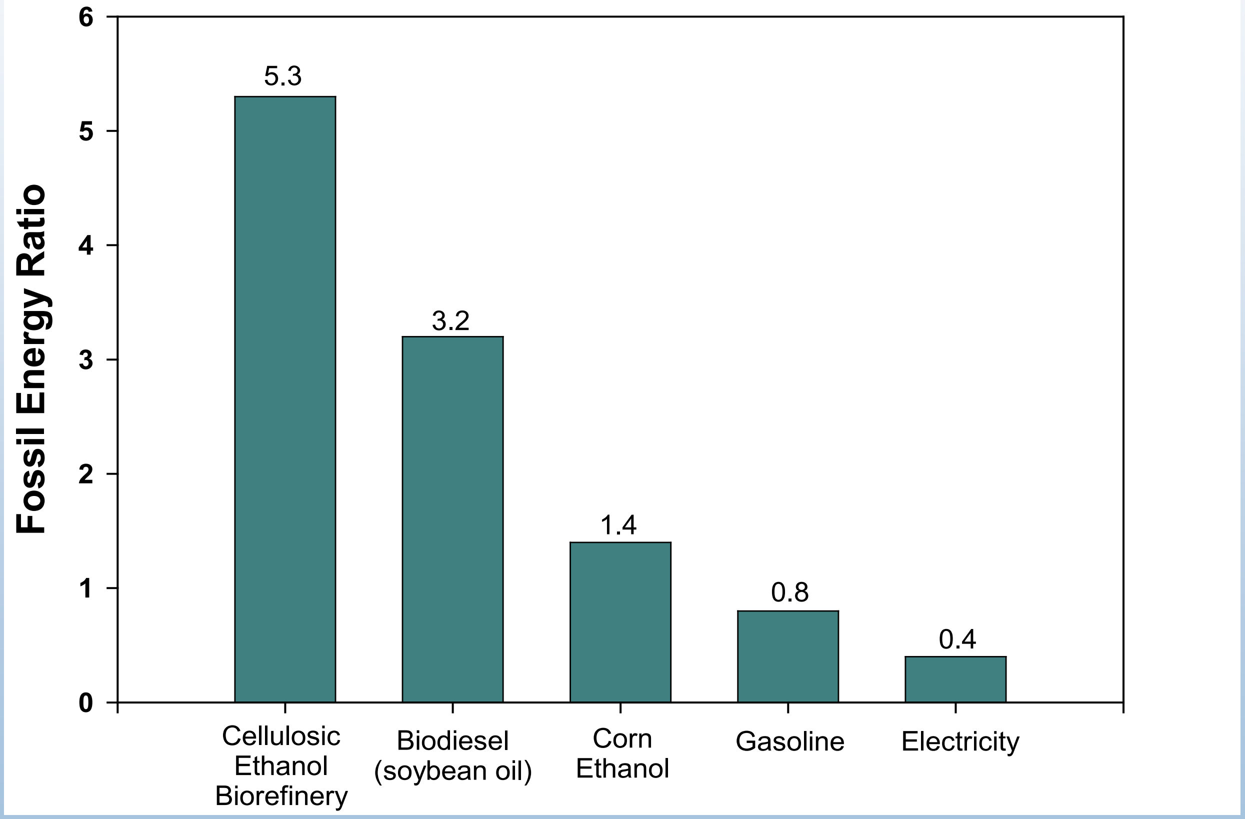
Ethanol Energy Balance



ANL, Energy Balance of Gasoline and E85, 2007

Fossil Energy Ratio

$$\text{Fossil Energy Ratio (FER)} = \frac{\text{Energy Delivered to Customer}}{\text{Fossil Energy Used}}$$



Biodiesel data from “An Overview of Biodiesel and Petroleum Diesel Life Cycles”, J. Sheehan, et al., 1998; J. Sheehan/M. Wang 2003

Factors Affecting Food Costs

- Higher Agricultural Commodity and Energy Prices
- Growth in Foreign Demand for Grains
- Reduced Foreign Competition and Supply
- Depreciating U.S. Dollar
- Buying of Grain and Oilseed Futures
- Weather, Drought

Factors Affecting Food Costs

- Less than one third of U.S. retail food contains corn as a major ingredient.

  Amber Waves, February 2008, USDA

- Corn exports increased from 53.9 metric tons in 2006/2007 to 63.5 metric tons in 2007/2008.

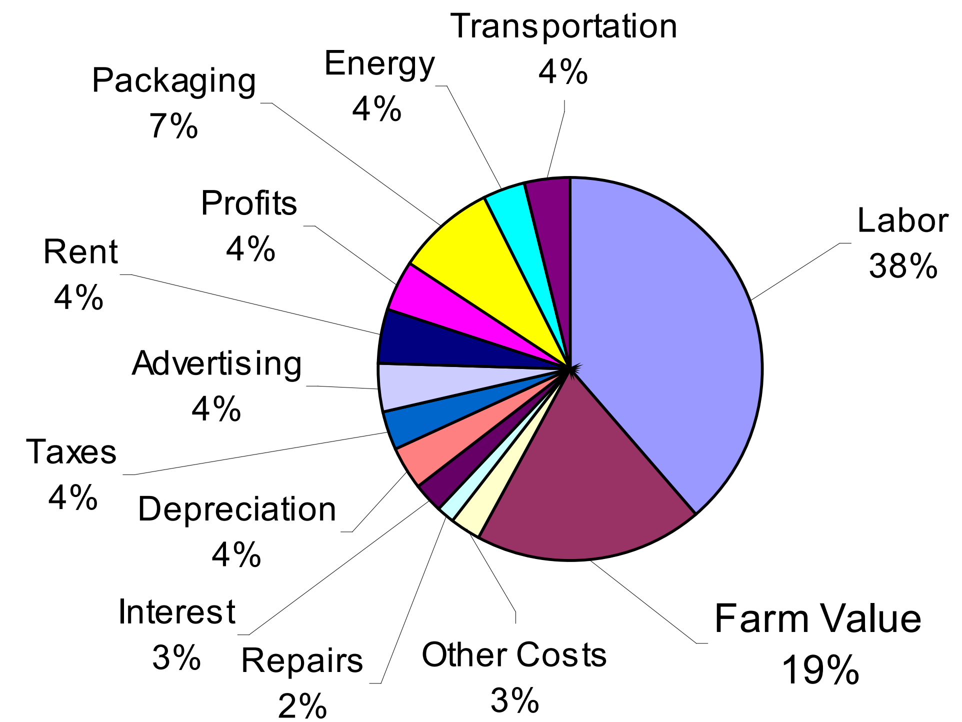
  USDA, FAS, 5/2008

- Ethanol production and availability may have positively impacted fuel costs.

- "Across all food consumed, 30% higher corn prices increase all average food prices by 1.1%."

  Center for Agricultural and Rural Development, Helen H. Jensen, Bruce A. Babcock, Iowa Ag Review, Summer 2007

Components of Retail Food Costs



Source: USDA

Direct energy costs and transportation costs account for roughly 8% of retail food costs in 2005.

Main Street Economist, Vol. III, Issue I; 2008; Federal Reserve Bank of Kansas City

Corn as Feed

- Feed Corn Usage
  - 2.6 lb of corn to produce 1 lb of chicken
  - 6.5 lb of corn to produce 1 lb of pork
  - 7 lb of corn to produce 1 lb of beef
- With corn at $2.28/bushel (20 year average), 56 lb/bushel or $.04/lb of corn, feed corn adds:
  - $.10/lb of chicken
  - $.26/lb of pork
  - $.28/lb of beef
- Using the 2007 average price of corn of $3.40/ bushel and assuming price increases would all be passed on to the consumer, prices would have increased:
  - $.05/lb for chicken
  - $.13/lb for pork
  - $.14/lb for beef

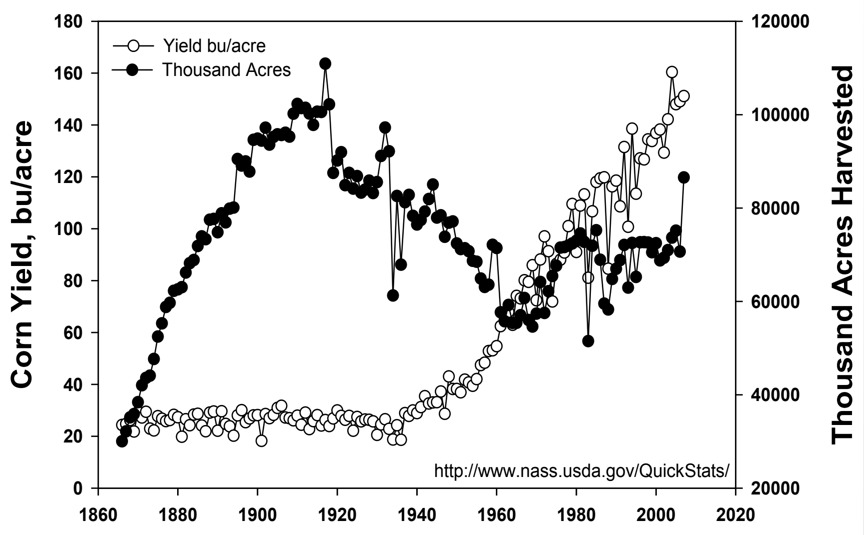
Amber Waves, Vol. 6, Issue 1; USDA

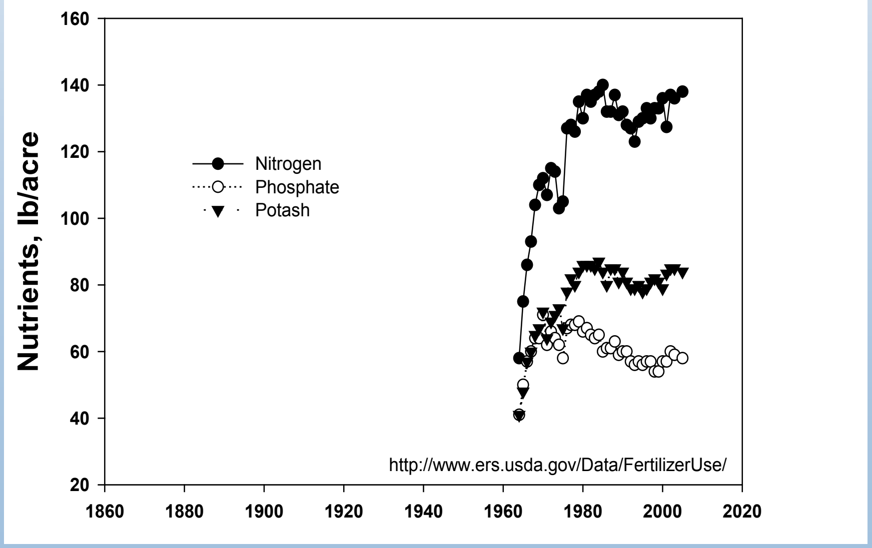
Corn Products for Human Consumption

- An 18-oz box of corn flakes contains approximately 12.9-oz of milled field corn
  - With corn at $2.28/bushel (20 year average), 56 lb/bushel or $.04/lb of corn, the corn value of the corn in this box is $.033.
  - Using the 2007 average price of corn of $3.40 and assuming price increases will all be passed on to the consumer, prices would increase by $.016.
- A 2-liter bottle of soda contains approximated 15 oz of corn in the form of high-fructose corn syrup.
  - With corn at $2.28/bushel (20 year average) the value of the corn is $.038.
  - Using $3.40/bushel prices would increase by $.019.

Amber Waves, Vol. 6, Issue 1, USDA

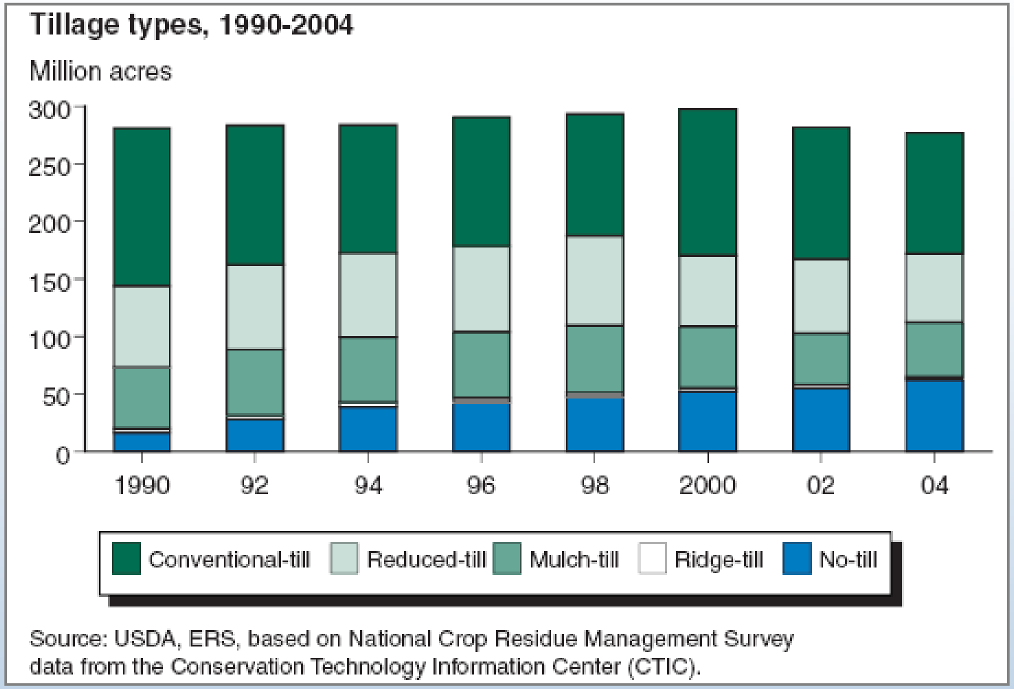
Corn Farming Productivity

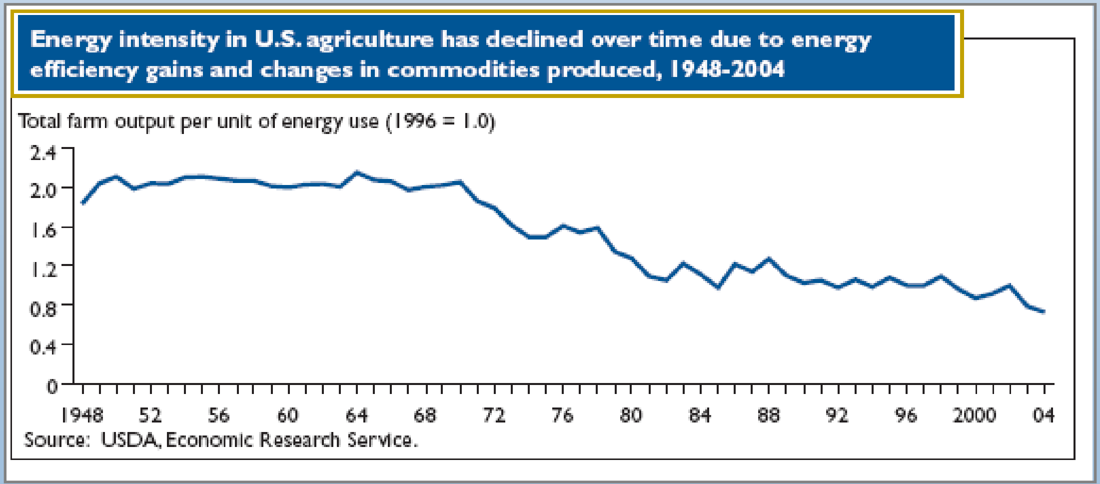




- Long-term trend for yield increase since 1940
- Acres planted generally decline or remain constant
- Fertilizer application increased rapidly until about 1980 then leveled off
- Yield increases continued unabated
  - Less fertilizer per bushel
  - Precision farming (GIS)
  - Improved crop strains
- Tillage has also been reduced

Farming Practices





- The primary ecological impacts of biofuels are in agriculture
- Significant economic incentives to farm with less inputs
  - Farm output per unit of energy down more than 50% in 60 years
  - Large growth (3x) in no-till farming
  - Data also show reduced use of pesticides and dangerous pesticides

Land Use

- **2007/2008**: Out of the 86 million corn acres harvested, 21 million acres were used to produce approximately 6.5 billion gallons of ethanol.
- **2017/2018**: Out of the 85 million harvested corn acres, USDA projects 28 million acres will be used to produce 4.9 billion bushels of corn for ethanol. This translates into approximately 13 billion gallons of ethanol using current published ethanol production yields (2.8 gallons/ bushel)

USDA Long-Term Agricultural Projection Tables, 2/2008;
RFA Ethanol Industry Outlook 2008; USDA Amber Waves, 4/2006

EISA 2007 Renewable Fuel Standard

36 billion gallons of total renewable fuels by 2022

- 21 billion gallons of advanced biofuels
  - 1 billion gallons of biodiesel
  - 16 billion gallons of cellulosic biofuels
  - 4 billion gallons from any source
- 15 billion gallons from corn ethanol

Possible 2017/ 2018 Scenario

Assuming trends, farm legislation, weather, and crop yield growth continue to track as in the past and Conservation Reserve Program (CRP) land can be used for corn and perennials…

	Gallons Ethanol
• **Crop Residue**: Cellulosic (Only 28% of land can have residual removed due to erosion concerns)	9.4-12.2 billion
• **CRP**: Cellulosic (12 million acres out of 37 million acres in CRP)	4.2-12 billion
• **CRP**: Corn (CRP acreage suitable for corn of 6.4 million acres)	2.6-3.1 billion
• **Corn** (28.3 million acres)	11.3-13.7 billion
Total for 2017/2018	**27.5-42 billion**

USDA Long-Term Agricultural Projection Tables, 2/2008; RFA Ethanol Industry Outlook 2008; USDA Amber Waves, 4/2006; USDA Amber Waves, 11/2007; USDA Agricultural Baseline Projections: U.S. Crops 2008-2017, 2/2008; ORNL, Biomass as Feedstock for a Bioenergy and Bioproduct Industry: The Technical Feasibility of a Billion-Ton Annual Supply, 4/2005, NAICC Annual Meeting Presentation, Hal Collins, USDA-ARS; NRDC Growing Biofuels: How Biofuels Can Help End America's Oil Dependence, 12/2004, EERE Biomass Program Web site

Corn Use

	2007/2008	2017/2018
Feed	45%	40%
Exports	19%	17%
Ethanol	25%	33%

USDA Long Term Agricultural Projection tables released 2/2008

Distillers grains from each bushel of corn used to produce ethanol substitutes for about a fifth of a bushel of direct corn feeding in livestock rations.

USDA Ethanol Expansion in the United States: How Will the Agricultural Sector Adjust? 5/2007

EIA’s Annual Energy Outlook 2008
(March 2008 early release)

“Although the situation is very uncertain, the current state of the industry and EIA’s present view of projected rates of technology development and market penetration of cellulosic biofuel technologies suggest that available quantities of cellulosic biofuels before 2022 will be insufficient to meet the new RFS targets for cellulosic biofuels, triggering both waivers and a modification of applicable volumes. … The modification of volumes reduces the overall target in 2022 from 36 billion gallons to 32.5 billion gallons.”

Water Usage

- 96% of field corn used for ethanol is not irrigated
- Water consumption for the other 4% is approximately 1.2 acre-feet of water per acre or approximately 785 gallons for every gallon of ethanol produced
- Water usage for ethanol production ranges from 3-4 gallons of water per gallon of ethanol produced.
- Future cellulosic production is estimated to use 1.9-6 gallons of water per gallon of ethanol
- Water usage for petroleum refining ranges between 2-2.5 gallons per gallon of gasoline

Water Usage for Current and Future Ethanol Production, Andy Aden, National Renewable Energy Laboratory, Southwest Hydrology, 9-10/2007

Price Impact on Gasoline

"The growth in ethanol production has caused retail gasoline prices to be $0.20 to $0.40 per gallon lower than would otherwise been the case."

The Impact of Ethanol Production on U.S. and Regional Gasoline Prices and on the Profitability of the U.S. Oil Refinery Industry, Working Paper 08-WP 467, April 2008, Xiaodong Du and Dermot J. Hayes, Center for Agricultural and Rural Development, Iowa State University

"Oil and gas prices would be about 15% higher if biofuel producers weren't increasing their output."

Francisco Blanch, Merrill Lynch, The Wall Street Journal, 3/2008

"The use of 10% ethanol blend saved Missouri drivers $.077 per gallon at the retail pump in 2007."

Impact of Ethanol on Retail Gasoline Prices in Missouri, John M. Urbanchuk, LECG LLC, 4/2008

Global Factors Affecting Food Costs

- Global Grain Supply: ↓
- Global Grain Demand: ↑
- Value of the Dollar: ↓
- Oil Demand: ↑
- Buying of Grain and Oilseed Futures: ↑

Global Grain Demand Increases

- Growth in foreign exchange holdings by major food importing countries (OPEC, Russia, Ukraine, China, Japan and other Asian countries)
- Protective policies by importers as food security measures
  - Reduced import tariffs and subsidies for consumers
- Biofuels
- Devaluation of the dollar, which may reduce importing costs
- Increased per capita income in developing countries, which increased per capita consumption of staples and diversified diet to include more meat and dairy
- Population Growth

Economic Research Service, USDA, WRS-0801, 5/2008

Global Supply: Fewer Sources and Reduced Supplies

- Adverse Weather
  - Droughts in Ukraine, Russia, Turkey, Australia, and other countries
  - Decreased yields due to weather in other countries
- Protective policies by exporters to reduce food price inflation
  - Eliminated export subsidies, export taxes, quantitative restrictions, export bans
- Reduction in research and development focused on yield-enhancing technologies slowing production growth

Economic Research Service, USDA, WRS-0801, 5/2008

Grains as Food

- U.S. food supply: Nutrients contributed from major food groups, per capita per day, in 2004 were 23.5% from grain

USDA Center for Nutrition Policy and Promotion, 2/2007

- Percent of diet in low-income countries
  - Low-income Asian countries: 63%
  - Low-income North Africa and Commonwealth of Independent States: 60%
  - Sub-Saharan Africa: 50%
  - Latin America: 43%
  - Eritrea and Ethiopia: 70%
  - Bangladesh: 80%

Amber Waves, Vol. 6, Issue 1; USDA

Ethanol Emissions

Well-to-Wheel GHG

- Decreases dependent on feedstock and energy source

Tailpipe

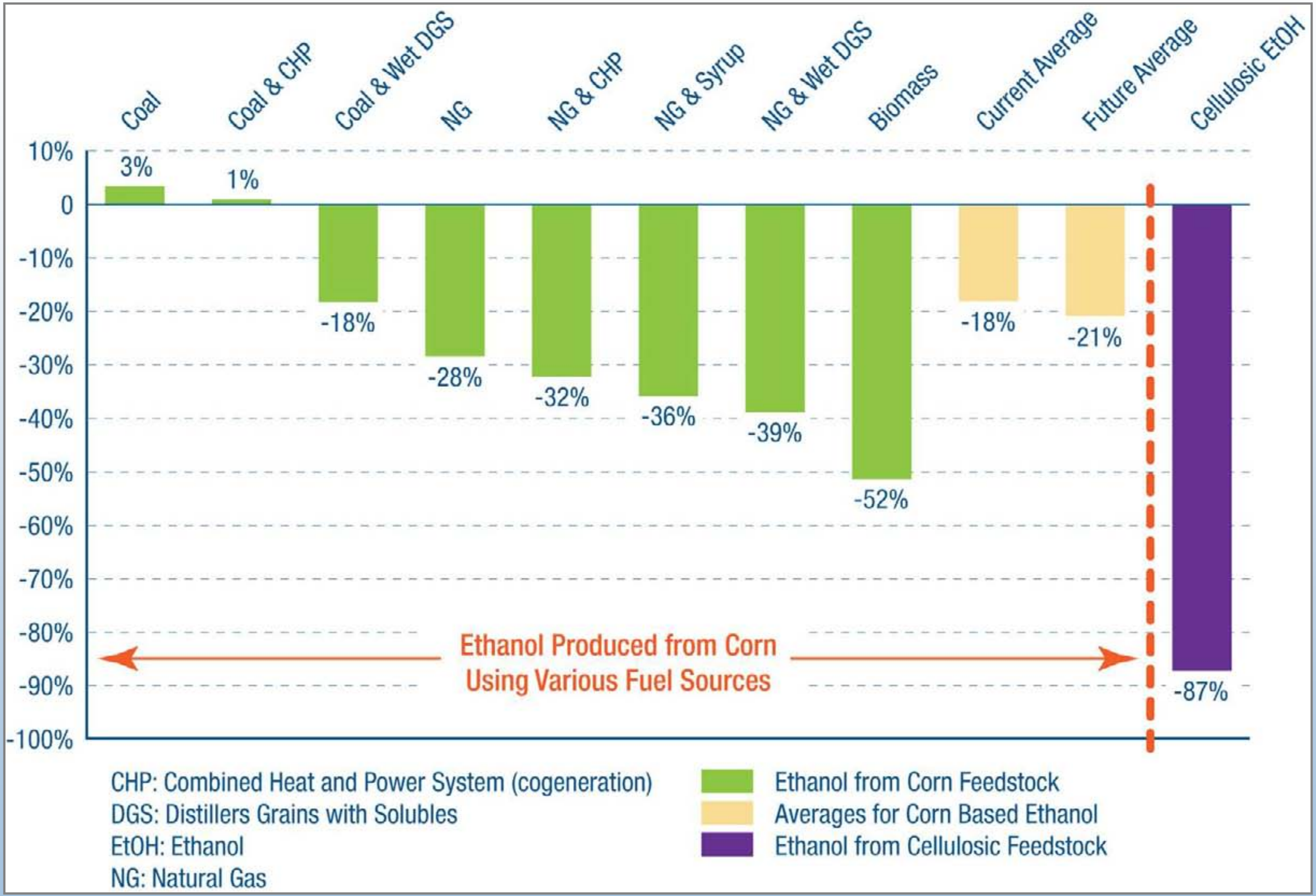
- Decreased NO_x, CO, benzene, butadiene, PM, and NMHC
- Significant increases in formaldehyde and acetaldehyde

Evaporative

- E10 increases evaporative emissions in non FFVs
- E85 lowers evaporative emissions

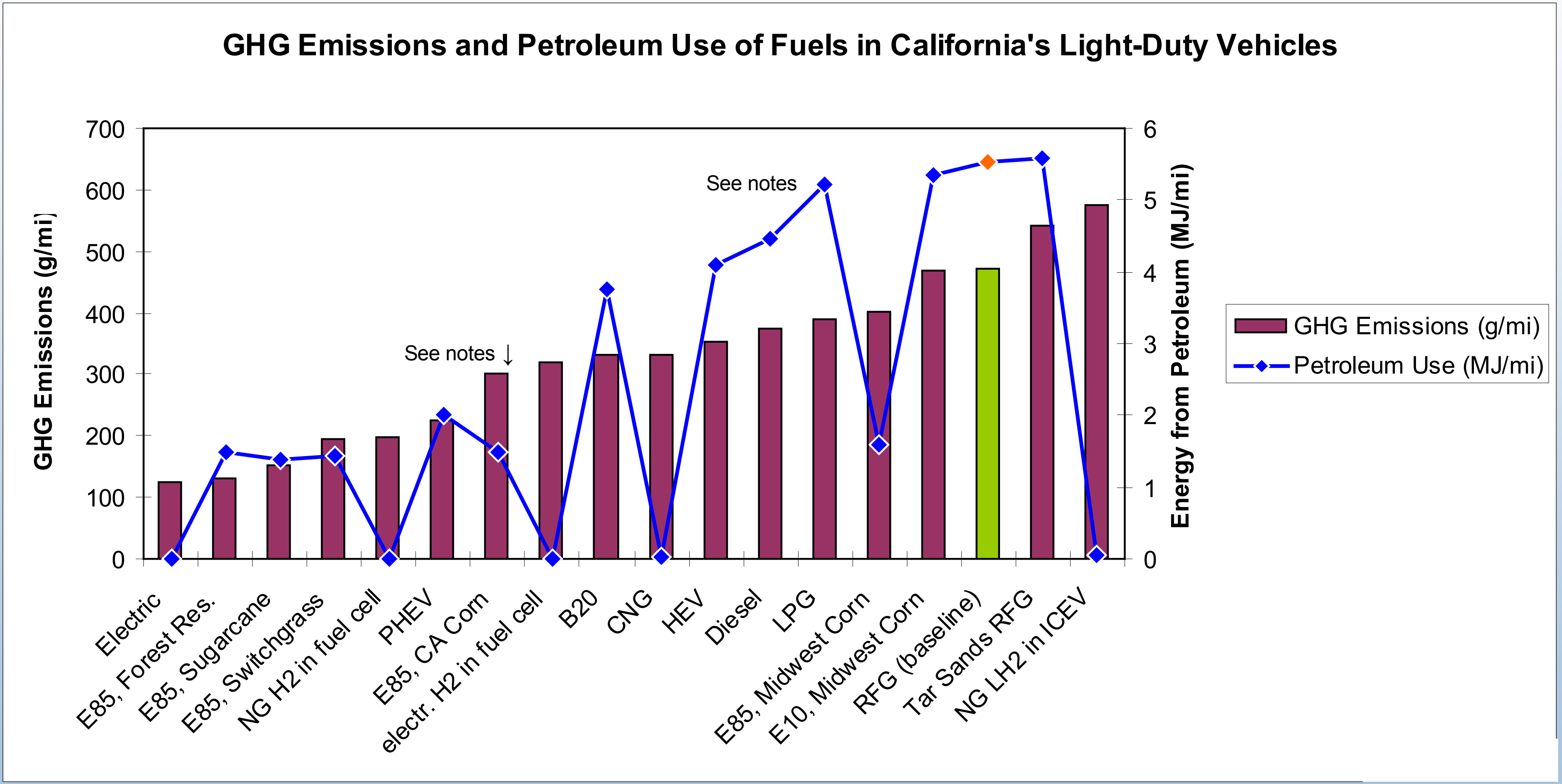
Other than EPA-certification data, there is limited current information available.

GHG Emissions



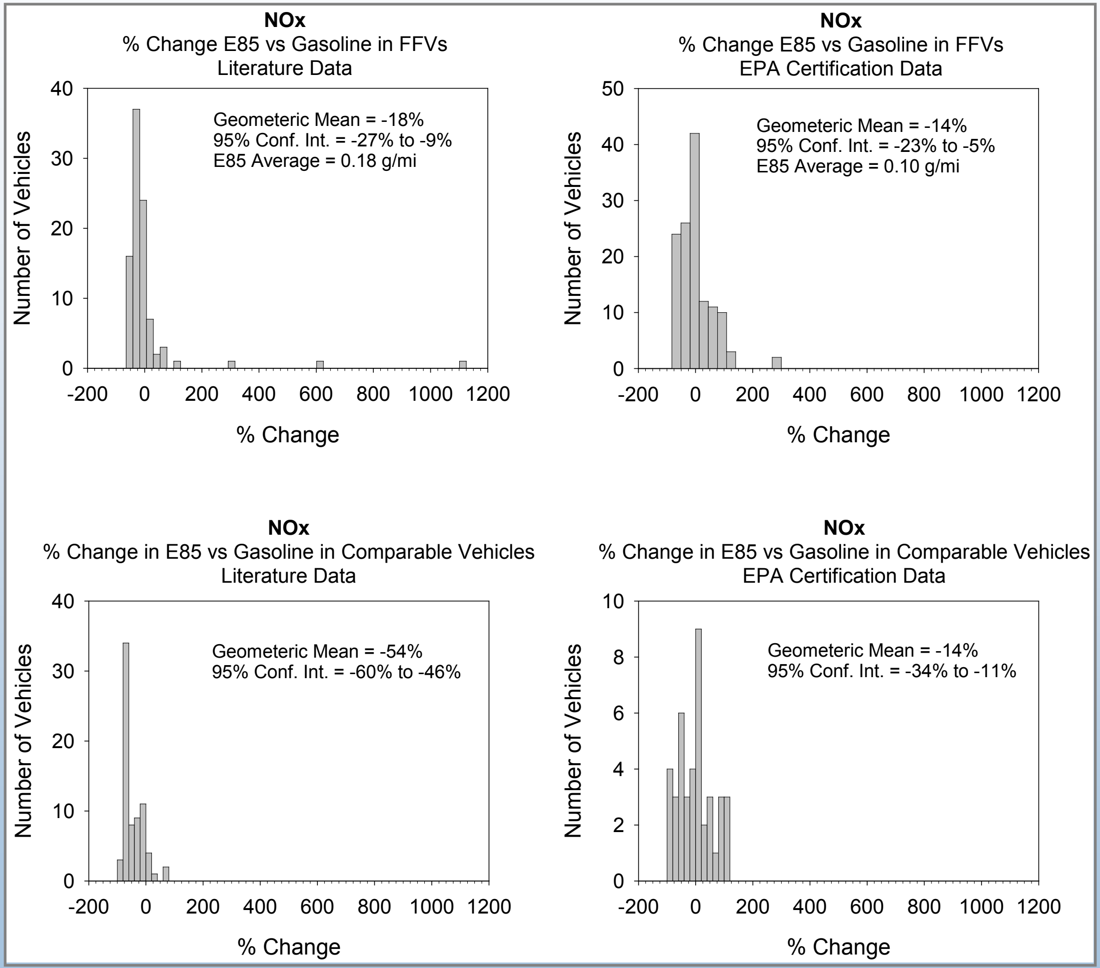
ANL, Well-to-Wheels GHG emission Changes: Fuel Ethanol Relative to Gasoline, 2/2007

California Energy Commission Comparison of Options for Reducing GHG and Petroleum Use



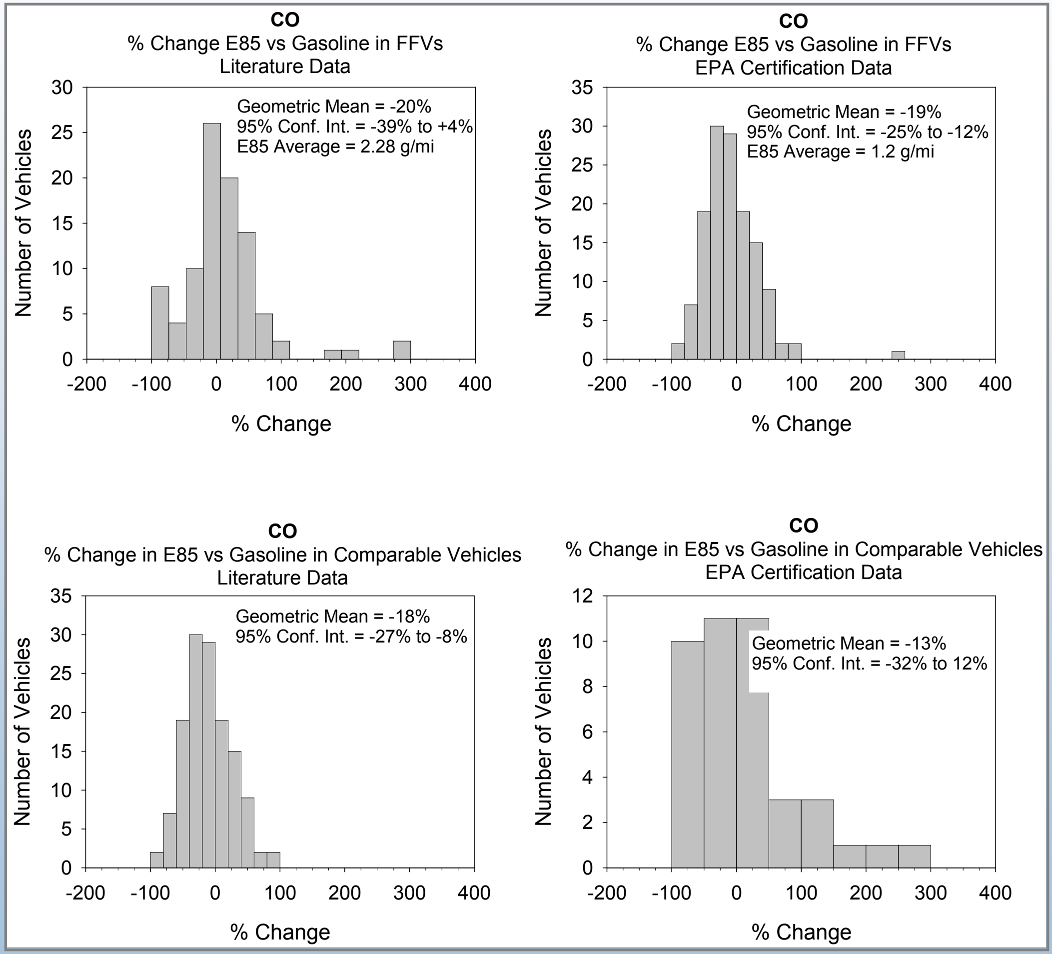
Fuel Cycle Assessment: Well-to-Wheels Energy Inputs, Emissions, and Water Impacts: Part of the State Plan to Increase the Use of Non-Petroleum Transportation Fuels; California Energy Commission, 2007; www.energy.ca.gov/2007public

NO_x Emissions Comparisons of FFVs Using E85 vs. Gasoline



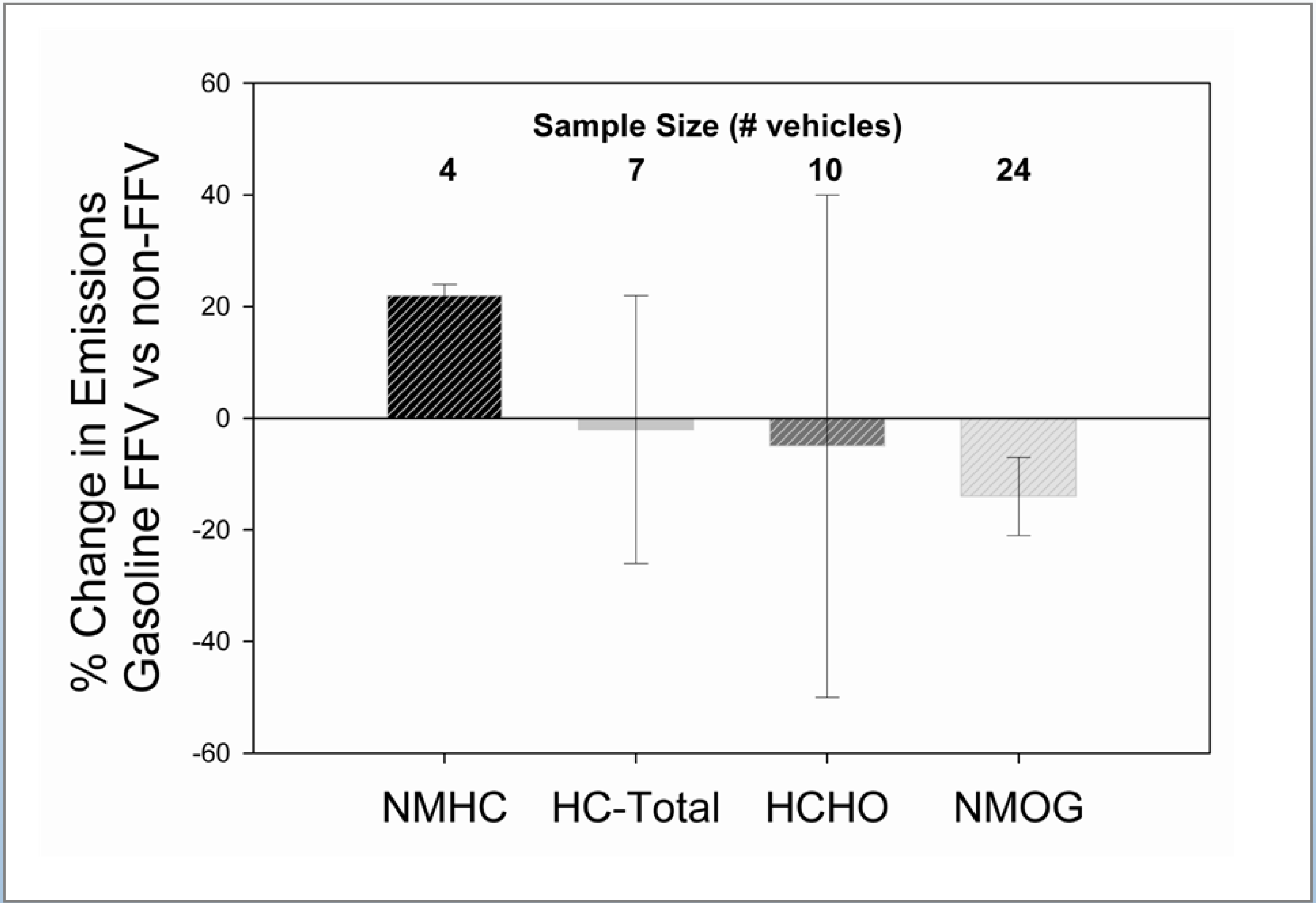
Effect of E85 on Tailpipe Emissions from Light-Duty Vehicles, McCormick/Yanowitz; accepted for publication in the Journal of the Air and Waste Management Association

CO Emissions Comparisons of FFVs Using E85 vs. Gasoline



Effect of E85 on Tailpipe Emissions from Light-Duty Vehicles, McCormick/Yanowitz; accepted for publication in the Journal of the Air and Waste Management Association

Effects on Tailpipe Emissions of Gasoline Used in FFV vs. Non FFV



Effect of E85 on Tailpipe Emissions from Light-Duty Vehicles, McCormick/Yanowitz; accepted for publication in the Journal of the Air and Waste Management Association

NREL Emissions Data Review

E85 versus Gasoline in non-FFV:	Tier 1	Tier 2
NMHC	-27%	--
NMOG	--	-2%
CO	-18%	-42%
NO_x	-54%	-37%
PM	reduced	reduced
Formaldehyde	+56%	+13%
Acetaldehyde	+2000%	no data
Benzene	-86%	no data
Butadiene	-91%	no data

NREL

California Low-Emission Vehicle Program and FFVs

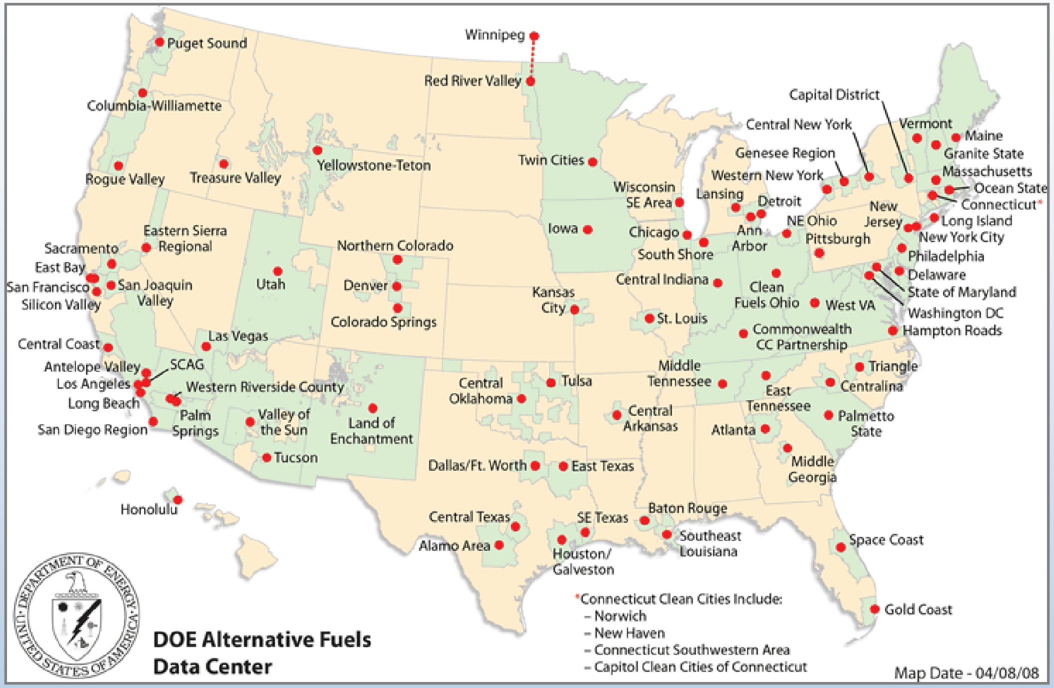
Excerpts from Alliance of Automobile Manufacturers Statement

- Emissions
  - Current vehicles have 99% fewer emissions than 1970s counterpart
  - E85-capable vehicles cannot meet CA LEV's SULEV standard
  - Expected that California will update 2008 program to so the average vehicle will have to meet the SULEV standard
- ZEV Mandates
  - 40% of vehicles sold in the state to certify to the ZEV standards
  - FFVs cannot meet the SULEV standards required
  - FFVs cannot meet the evaporative emissions in the PZEV category
  - To date, no FFVs have been certified to meet any of the ZEV standards
- CO_2
  - No practical way for automakers to get credit toward their fleet averages
  - Require proof that the vehicle is operating on E85

Where can I get more information?

Clean Cities

- DOE's Clean Cities
  - 86 coalitions bring local and regional resources together
- Technical Assistance
  - Industry and national laboratory experts for local implementation issues
- Strategy Development
  - National partnerships with industry, manufacturers, etc., to enable local progress



Data and Tools

- Technology- and User-Specific Tools to Support Implementation
  - Fleet Decision Tools
  - Cost Calculators
  - Fuel Implementation Resources

Data and Tools

- Alternative Fuels and Advanced Vehicles Data Center
  - Primary source of data on implementation of alternative fuels and more
  - Federal and state incentives, fueling station locations, available vehicles, industry resources
  - Averaging more than 1 million pages of information viewed per month

Resources

- NREL Web Sites
  - www.nrel.gov/vehiclesandfuels
  - www.nrel.gov/vehiclesandfuels/fleettest
- DOE Web Sites
  - www.eere.energy.gov/cleancities
  - www.eere.energy.gov/afdc
  - www.eere.energy.gov/vehiclesandfuels/epact
  - www.eere.energy.gov/vehiclesandfuels/avta/index.html

Thank you!

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