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The Logistics, Economics and Policy of Ethanol Markets in the US and the Potential for Imports from Latin America

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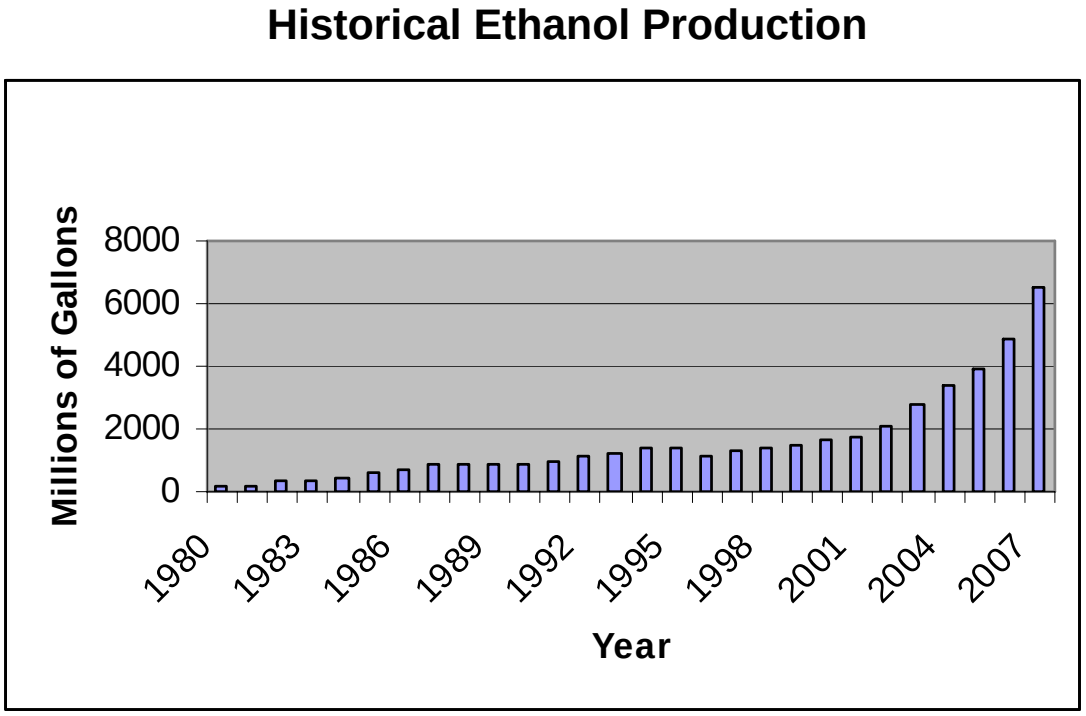
http://www.rice.edu/energy/publications/usbiofuelpolicy.html

Policy

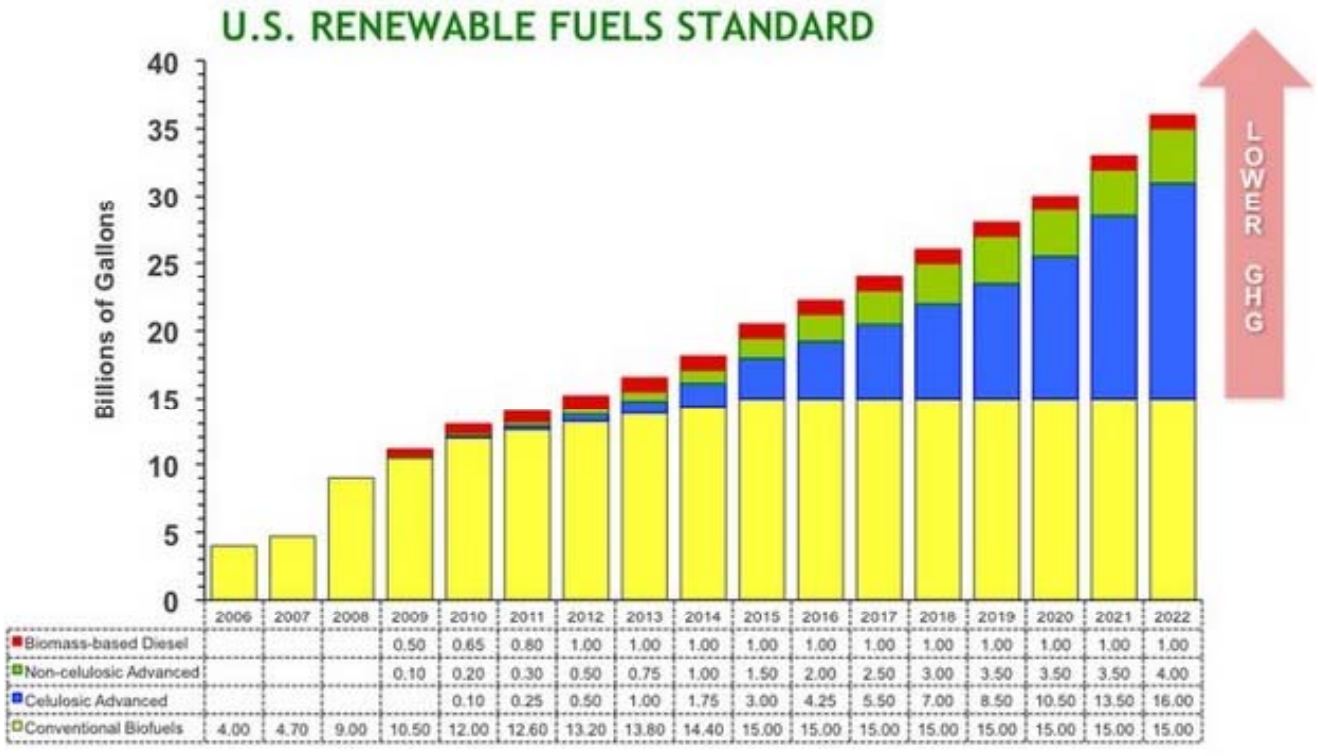
- US Energy Bill (2005) - 7.5 billion gallons of renewable fuel by 2012.
- Energy Independence and security Act (2007)
  - 9 bill gals by 2008
  - 36 bill gal by 2022 (of which 21 bill gals from “advanced biofuels”)
- 6 bill gals to replace current levels of MTBE fuel additive
- 60 billion gals to replace 30% of current gasoline consumption
- The US currently has capacity to produce 10.3 bill gals. Production in 2008 was 9.2 bill gals. (Brazil produced 6.4 bill gals)
- Californina to reduce GHGs by 10% by 2020 and then further by 2050. Low Carbon fuels are one way to meet requirement.

Current Policies & State of Industry

- **3 Major Policies:** Blenders credit, Tariff on imported ethanol, Renewable Fuels Standard
- **Historical Rapid Industry Growth:** Policy has produced a high growth in corn ethanol production to 10.4 billion gallon/year (678,000 b/d) in first 9 months of 2009



Current Renewable Fuels Standard



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Biomass-based Diesel				0.50	0.65	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Non-celulosic Advanced				0.10	0.20	0.30	0.50	0.75	1.00	1.50	2.00	2.50	3.00	3.50	3.50	3.50	4.00
Celulosic Advanced					0.10	0.25	0.50	1.00	1.75	3.00	4.25	5.50	7.00	8.50	10.50	13.50	16.00
Conventional Biofuels	4.00	4.70	9.00	10.50	12.00	12.60	13.20	13.80	14.40	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00

Source: http://english.unica.com.br/userFiles/rfs%202.jpg

Problems Reaching RPS:

- **No commercial cellulosic ethanol yet**
- **10% ethanol "blend wall" at about 14 billion gallons**
- **Few flex-fuel vehicles or E-85 stations**
- **No more than 10% ethanol by volume allowed in vehicles**
- **PLUS: Economic, Logistic, and Environmental Issues**

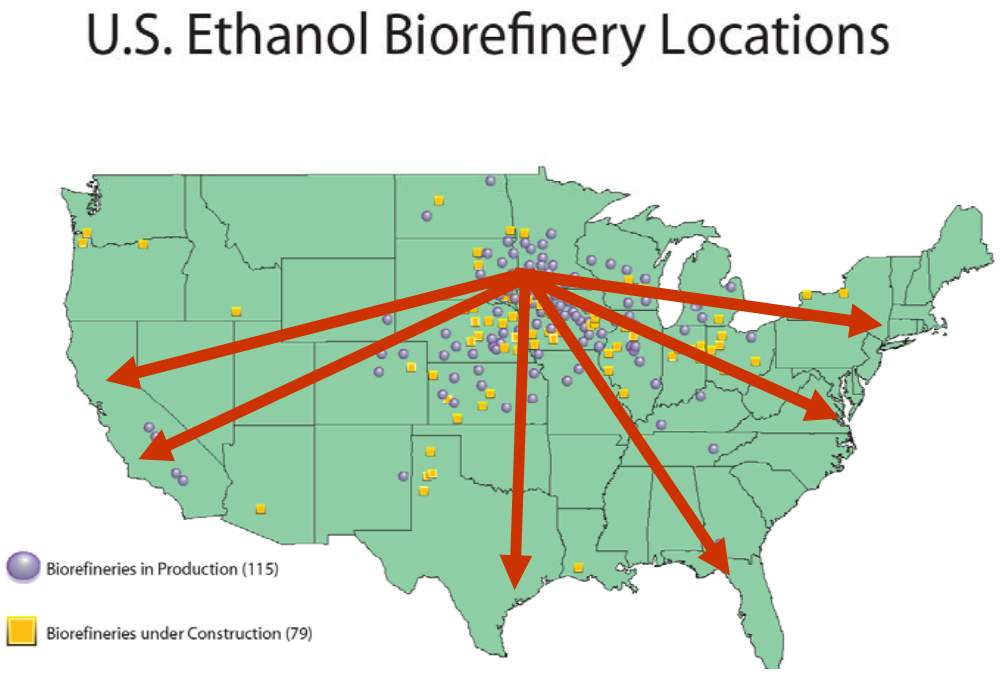
- Second generation cellulosic ethanol is still in the future
- Given current technology sugarcane is much more efficient and has more environmental benefits than corn
- A significant part of the US market for transport fuels is on the coasts - easily accessible to imports by sea
- Interest in Caribbean countries - duty-free access under CAFTA
- Mexico has duty-free access under NAFTA
- South America supplies promote US energy security.
  - Potentially a significant source of supply
  - Promotes geographical diversification of energy supplies
  - Producers are politically stable.

US Ethanol Protections

- Subsidy 51 cents/gal
- Tariff 54 cents/gal
- Plus ad valorem levy of 2.5%US
- Imports from CBI are duty free if produced there
- Reprocessed ethanol is also duty free but subject to quotas of 7% of US Market (Actual imports are far below quota - only 3% of US market in 2006).
- Countries that joined CAFTA were given larger quotas (Costa Rica, El Salvador)

- **Logistics**

Pipelines



Source: Renewable Fuels Association

Little Ethanol is currently transported by pipeline and logistical issues block extensive use of pipeline

•Supply is in Midwest but existing pipelines flow to Midwest not from Midwest

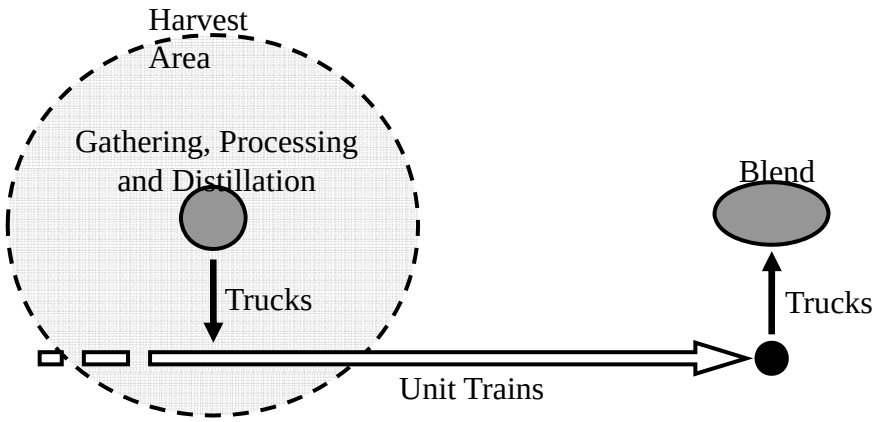
• High capital costs discourage construction and supply scale in individual locations are relatively small

• Concerns about corrosion and water mixing discourage use of existing infrastructure

Pipelines Cheaper per Gallon

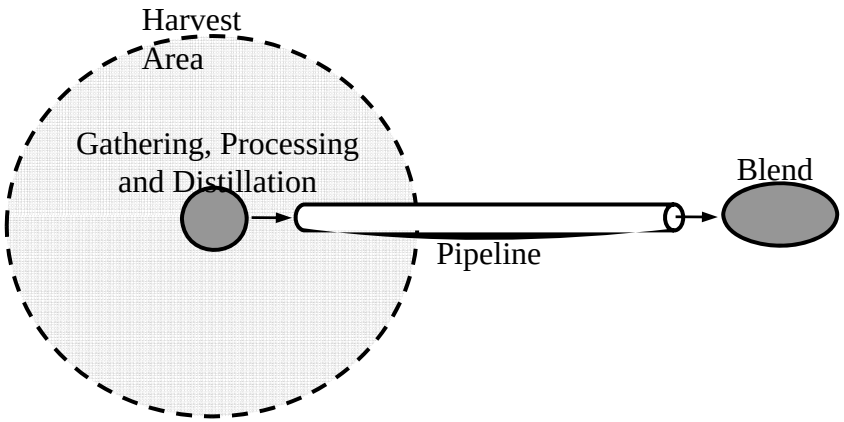
	Cost ($/gallon)	Volume (gallons)
… by Truck	$ 0.20	6,000
… by Rail (Unit Train)	$ 0.10	23,000
… by Barge	$ 0.05	400,000
… by Pipeline	$ 0.02	2,000,000

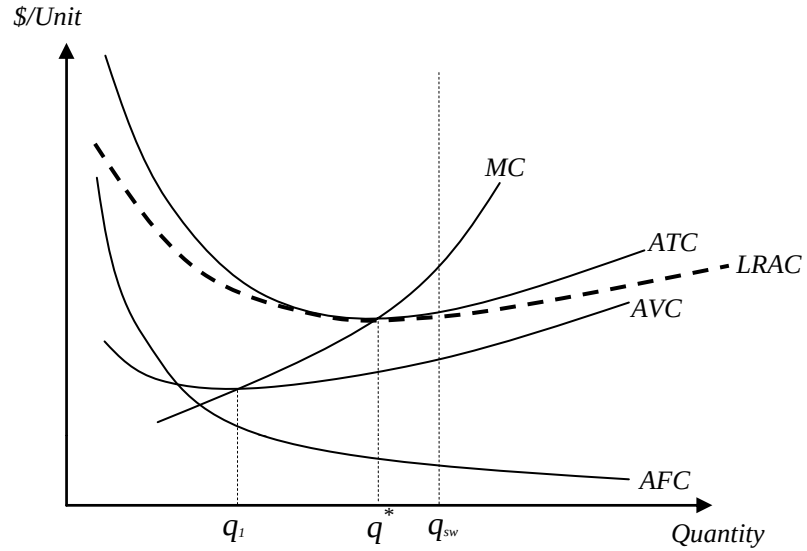
Ethanol Transportation Mode (2005):
60% - Rail
30% - Truck
10% - Barge

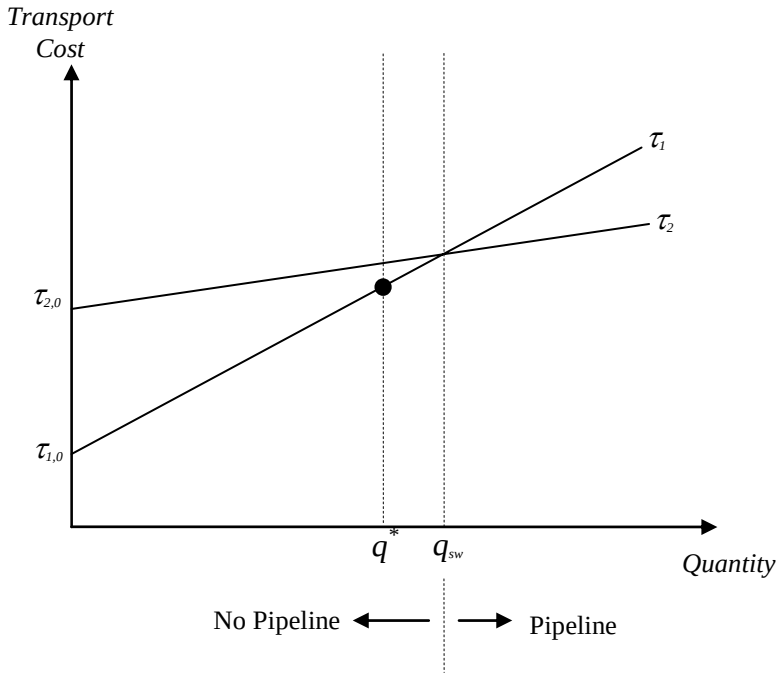


Economies of Scale

- No trend towards construction of large scale ethanol plants
- Farrell (2007) estimates increasing capacity from 40 million gallons/year (MGY) to 100 MGY reduces per-gallon cost by only $0.02/gallon; Urbanchuk (2008) estimates reduction at $0.03/gallon.
- Large enough volumes to support pipeline transport likely would need an ethanol gathering system. It is not clear if amount of ethanol will be high enough to generate multiple pipelines.
- A lack of sufficient economies of scale may limit growth as low cost transport options may not be commercially unachievable.
- Productivity improvements are needed.

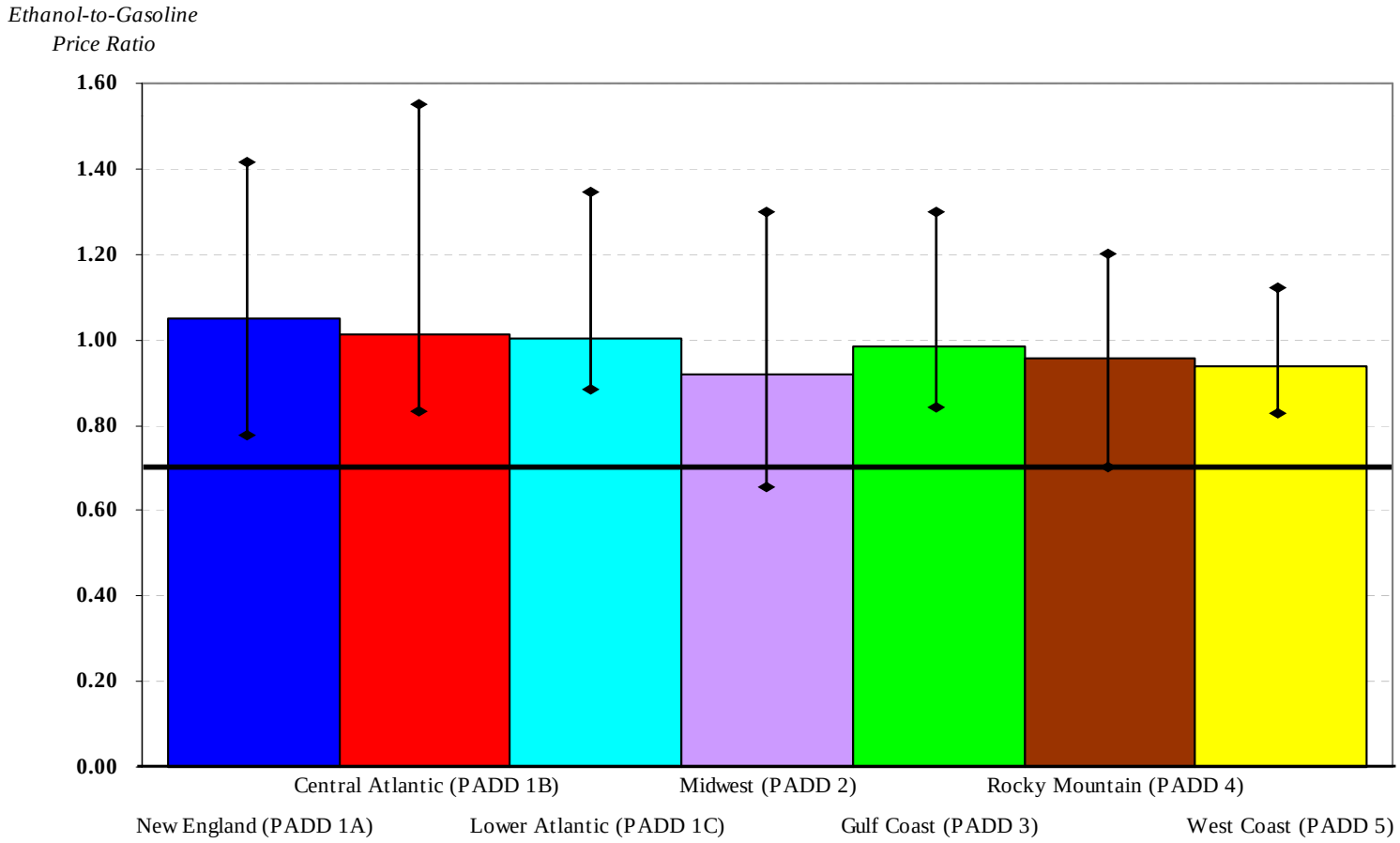






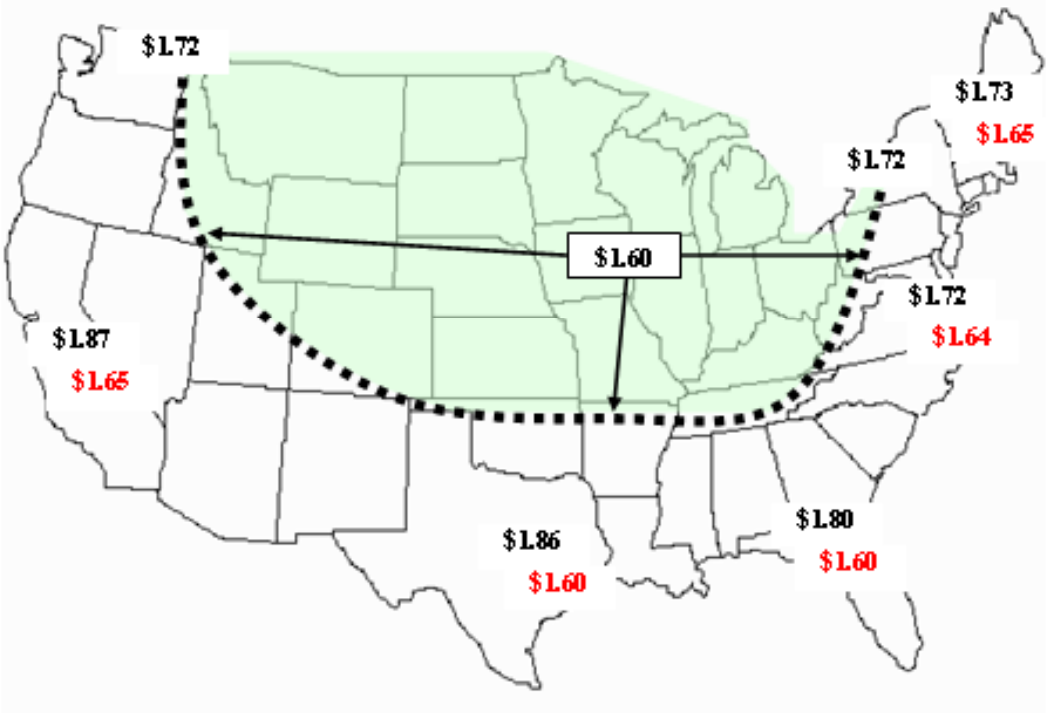
Ethanol Costs around Country

- The price of ethanol (E-85), if based on heat content parity, should run at roughly 74% of the price of gasoline (E-10).
- However, in no part of the country has this relationship unfolded (height of bars). In fact, only in the Midwest and Rockies have prices been at or below the parity relationship in the time period examined (5/00-4/09).



Arbitrage Point for Ethanol

- Dotted line represents the arbitrage point for ethanol imported from Brazil ($0.88 production + $0.18 shipping + $0.54 tariff) and ethanol produced in the Midwest ($1.60 CBOT). Note these data are representative of costs in April 2009.
- When transport costs are included, imported ethanol should outcompete domestic ethanol.
- Why does it not? One explanation is related to the fact that scaling up production in Caribbean, Central America and Brazil requires certainty of market. Protectionism in the US is a threat to profitability.



Latin America Supply Potential

Arable Land (1000 Ha)	**Permanent Crops** (1000 Ha)	**Sugarcane Harvested** (1000 Ha)
101,124	17,042	7,359.5

	Sugarcane Acreage (Thousands of ha)	**Yields** (Liters/ha)	**Ethanol Production** (Millions of Gallons)
Scenario 1 Low	14,720	5,625	**21,789**
Scenario 3 High	48,900	6,888	**88,638**

Arable Land and Crops by Country

	Arable Land (1000 Ha)	**Permanent Crops** (1000 Ha)	**Sugarcane Harvested** (1000 Ha)
Belize	70	32	0.0
Brazil	59,000	7,600	5,806
Colombia	2,004	1,609	42.6
Costa Rica	225	330	0.0
Dominican Rep.	820	500	85.1
El Salvador	660	250	54.3
Ecuador	1,348	1,214	93.9
French Guiana	12	4	0.1
Guatemala	1,440	610	190.0
Guyana	480	30	49.0
Honduras	1,068	360	75.9
Jamaica	174	110	39.0
Mexico	25,000	2,600	650.0
Nicaragua	1,925	236	46.4
Panama	548	147	34.9
Peru	3,700	610	61.5
Venezuela	2,650	800	130.7
Totals	101,124	17,042	7,359.5

Ethanol Potential in Cuba

- Estimating Cuba's potential is easier:
  - At one time Cuba was the world's largest exporter of sugar.
  - It was a major supplier of sugar to the US before the Revolution and to the Soviet Union in the 1970s and 80s.
  - Sugar production, which was as high as 8.1 million tons in 1988, has fallen to 1.5 million tons in 2006.
  - Acreage devoted to sugar was reduced by over 60% since 2003.
  - Sugarcane yields have fallen from 58 tons/Ha to 28.
- One can assume that Cuba can reverse this trend and re-plant sugarcane in the areas that have been abandoned - or in some cases planted with other crops. (This requires the additional assumption that Cuba has a comparative advantage in sugarcane).

Ethanol Replacing More MTBE Than Gasoline

- **Ethanol Production from January-September 2009: 678,000 b/d**
- **Fuel Needed to Replace MTBE: 400,000 b/d**
- **Fuel replacing gasoline after energy conversion: 185,000 b/d**
- **This replacement represents only 2 percent of US gasoline supply and is currently not a cost effective energy security measure**
- **Extremely expensive policy at cost per substituted barrel: $82, or $1.95/gallon on top of retail price ($4 billion total)**

- **Comparison:** Relative to each other, sugarcane has a more positive energy balance than corn
- **Most studies find a slightly positive energy balance for production of ethanol from corn:** Pimentel and Patzek (i.e. 2005) is outlier
- **Energy balance should not be the sole determinant of ethanol feedstock, however. Other direct environmental and economic externalities are more relevant.**

- Not commercially ready
- Better carbon balance: but still might be worse than traditional gasoline depending upon land use
- Some interest among industry: ExxonMobil's new joint venture with Synthetic Genomics, Inc. for algal fuel

Estimates of Ethanol Output: Yields = (5,600 Liters/HA)					
Scenarios	Sugarcane Acreage (Thousands HA)	Millions Liters	Million Gal	Million Barrels	Thousand Barrels /day
Harvest Ares +20%	9,998	55,989	14,792	352.2	964.8
Harvest Area Doubles	16,663	93,315	24,654	586.9	1,608.0
Harvest Area +150%	20,829	116,644	30,817	733.7	2,010.0
5% of Ag Land	24,820	138,991	36,722	874.2	2,395.1
10% of Ag Land	49,640	277,982	73,443	1,748.4	4,790.2

Estimates of Ethanol Output: Yields = (7,000 Liters/HA)					
Scenarios	Sugarcane Acreage (Thousands HA)	Millions Liters	Million Gal	Million Barrels	Thousand Barrels /day
Harvest Ares +20%	9,998	69,986	18,490	440.2	1,206.0
Harvest Area Doubles	16,663	116,644	30,817	733.7	2,010.0
Harvest Area +150%	20,829	145,805	38,522	917.1	2,512.5
5% of Ag Land	24,820	173,739	45,902	1,092.8	2,993.9
10% of Ag Land	49,640	347,478	91,804	2,185.5	5,987.8