

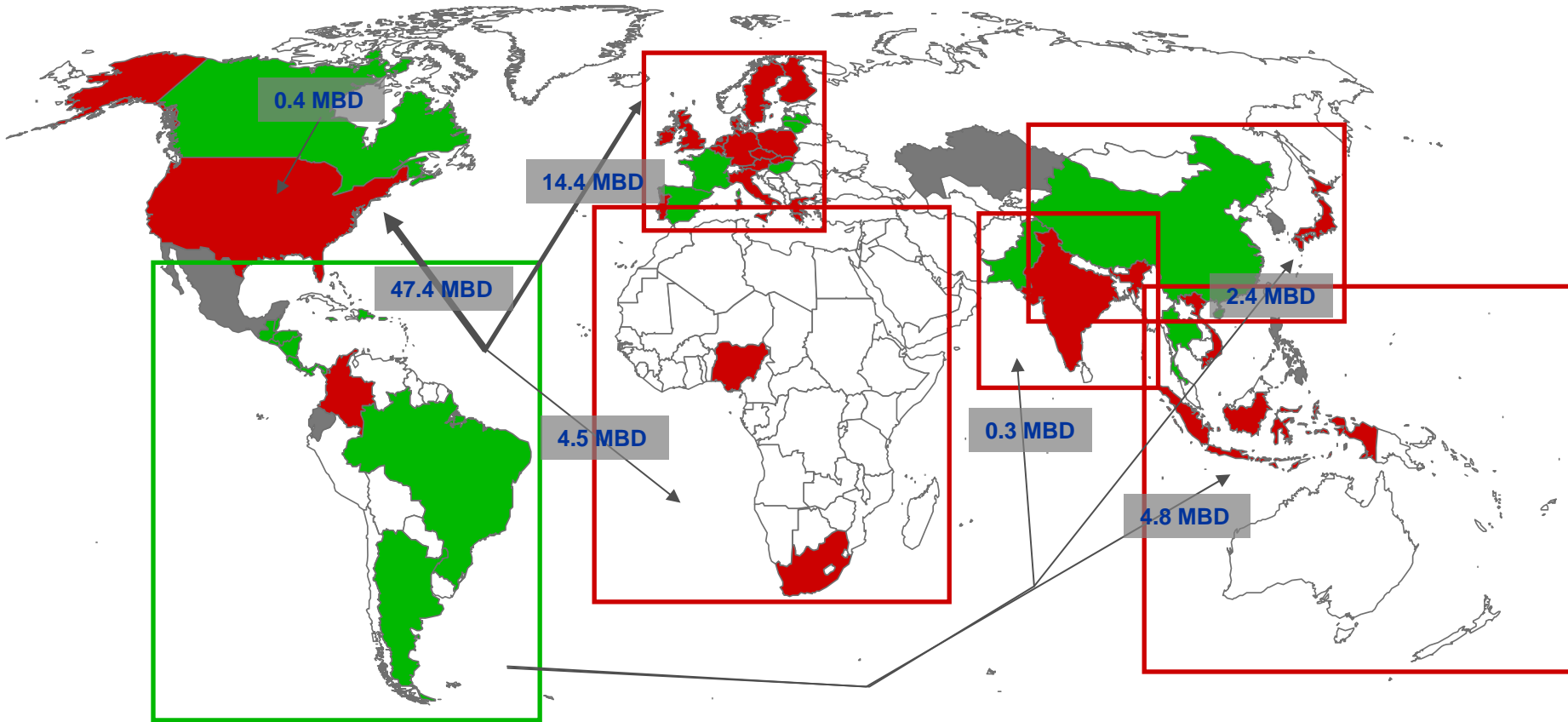
Ethanol and Biodiesel

September, 2007

Gauri Jauhar

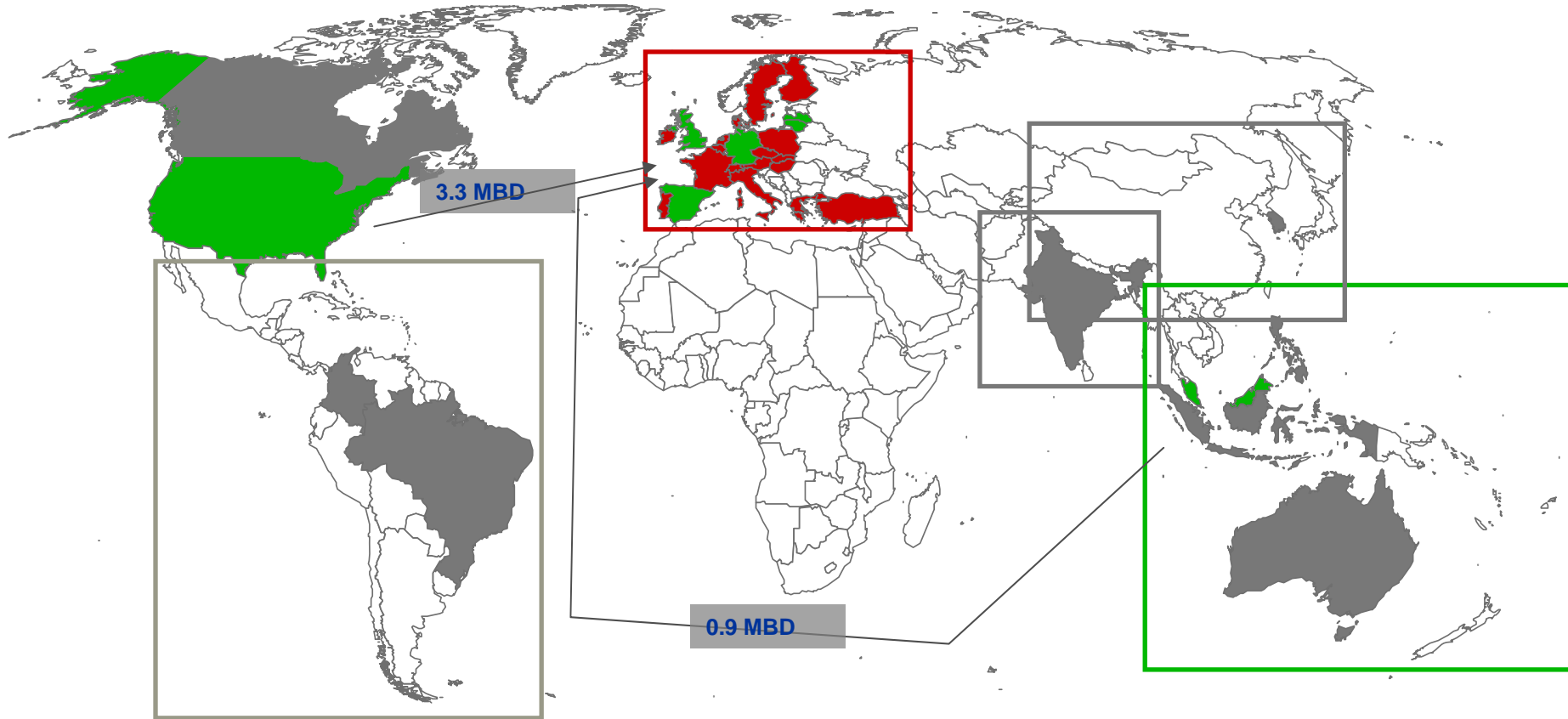


2006 Ethanol Flow



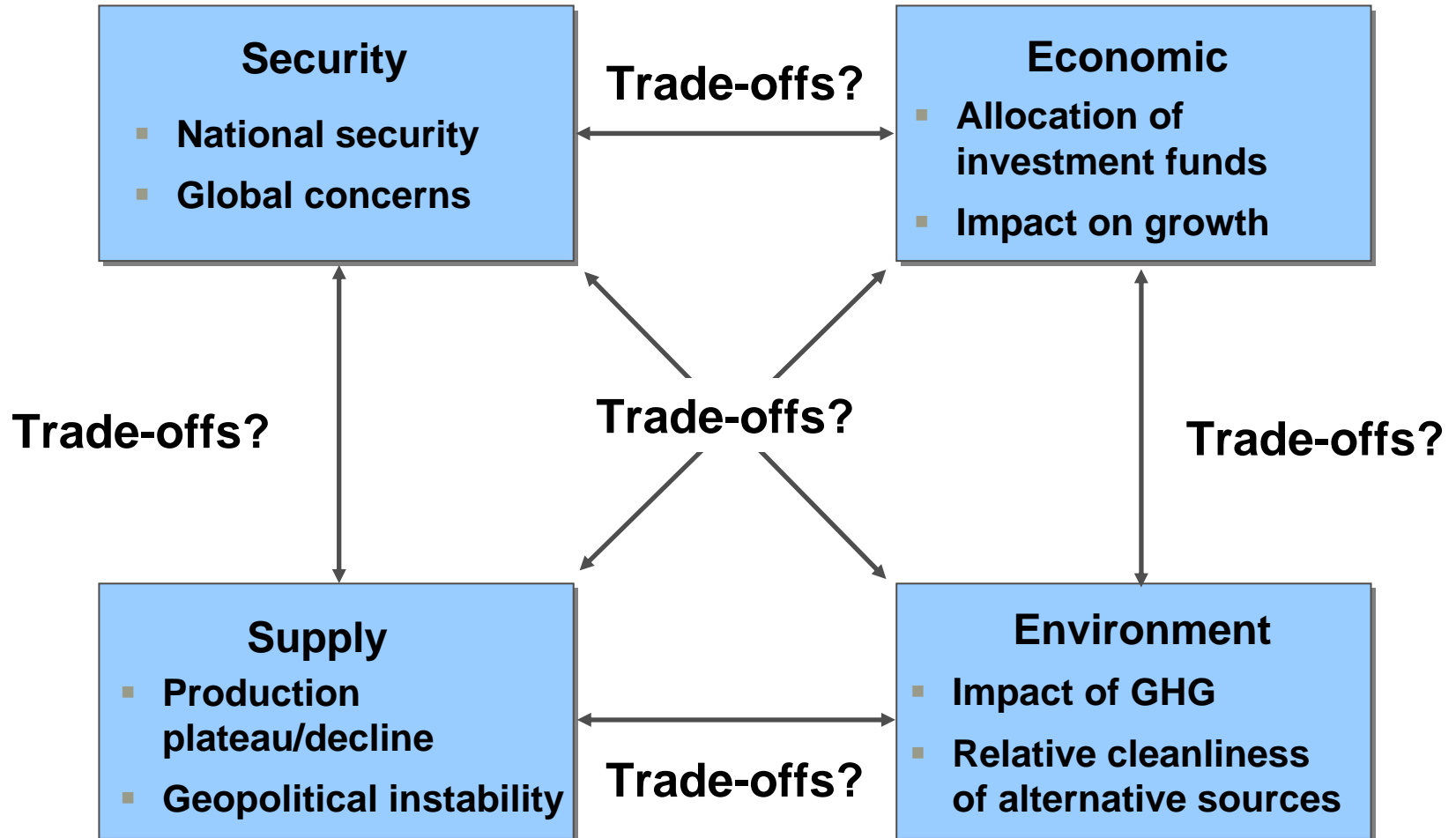
- Green = net exporters
- Red = net importers
- Grey = balanced

2006 Biodiesel Flow



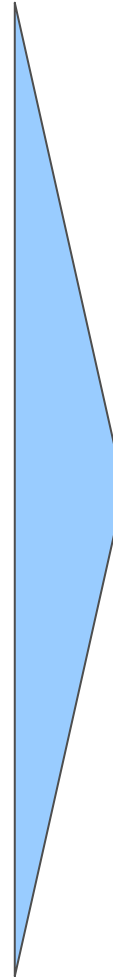
- Green = net exporters
- Red = net importers
- Grey = balanced

Role of Policy-Makers



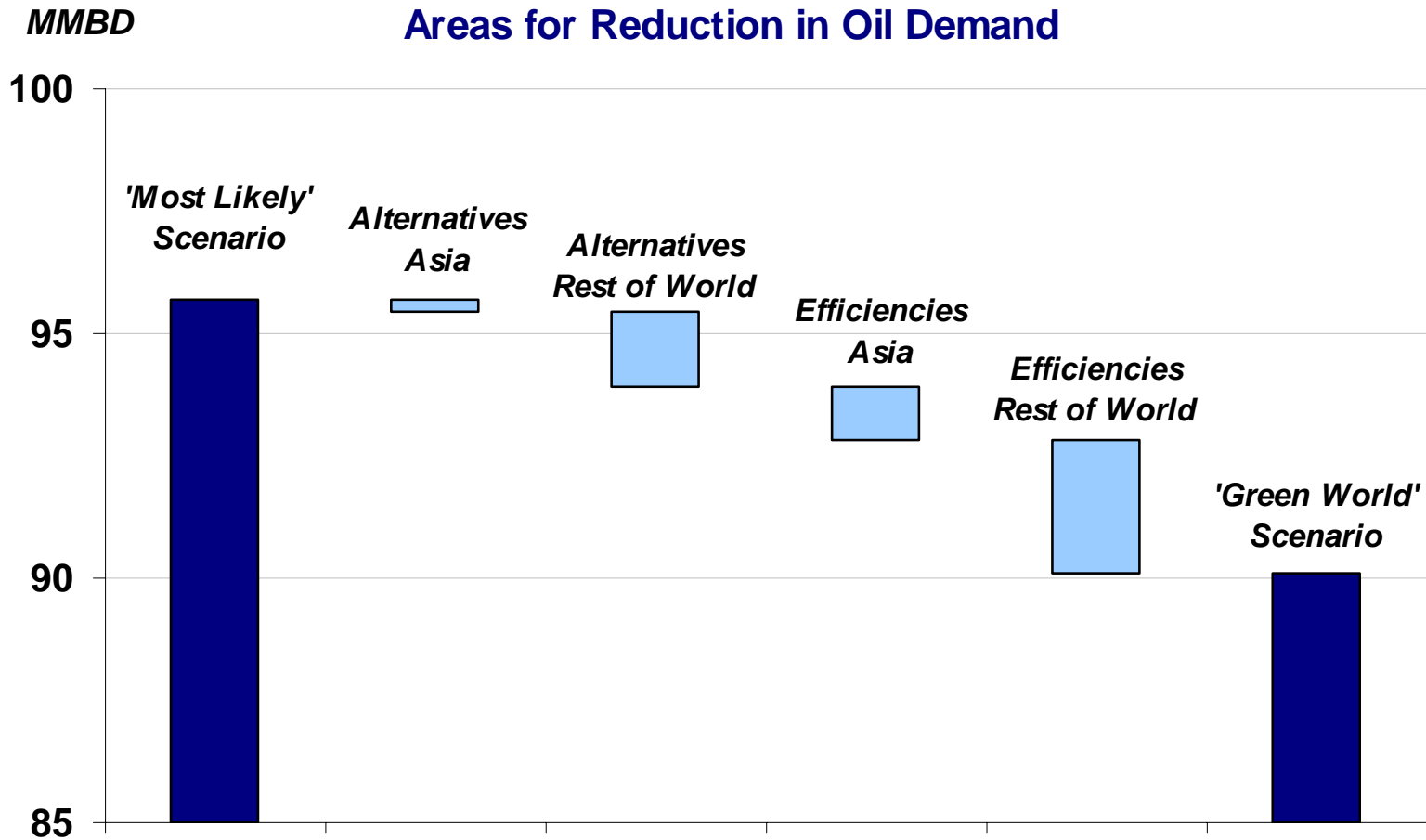
Growing Probability for “Green World”

- **Demand-reduction initiatives become separate from oil prices...**
- **...and are now driven by energy security and environmental concerns**
- **Consumers adopt a culture of environmental sensitivity**
- **Some companies recognize the potential for market opportunities**



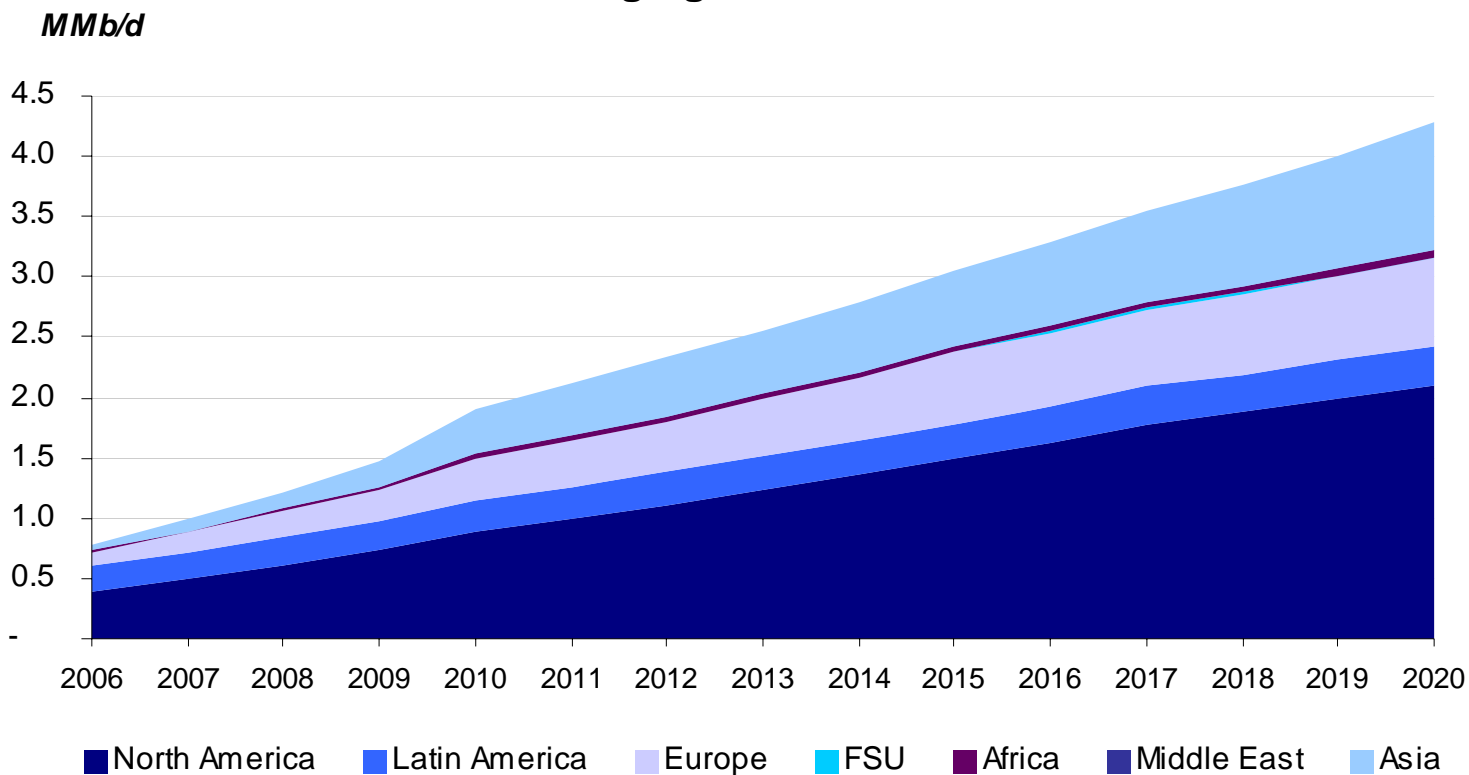
- **Technologies and regulations start making material impact on future oil demand**
- **The decline in demand growth accelerates as the current fleet and other products are replaced...**
- **...and emerging economies are able to “leapfrog”**

Potential Impact on 2017 Oil Demand



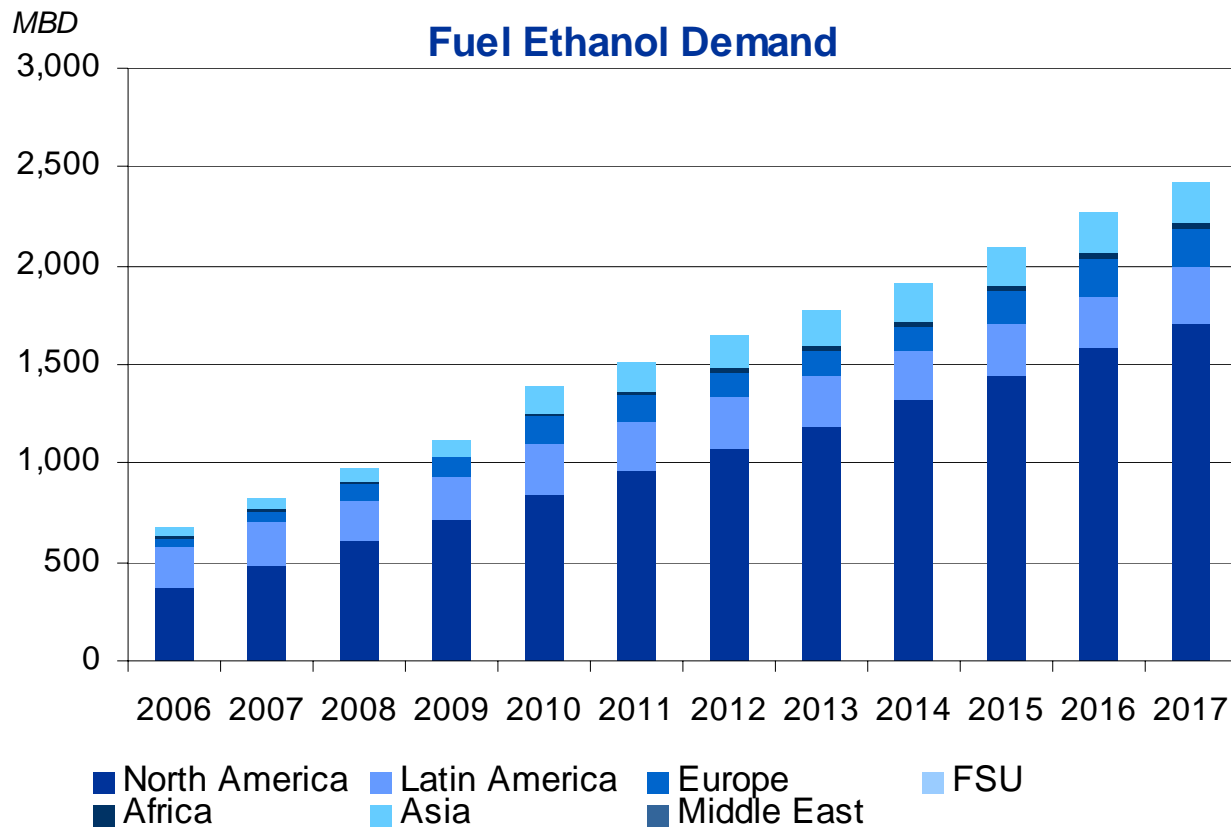
Biofuels Demand

Biofuels Demand "Emerging Green World"



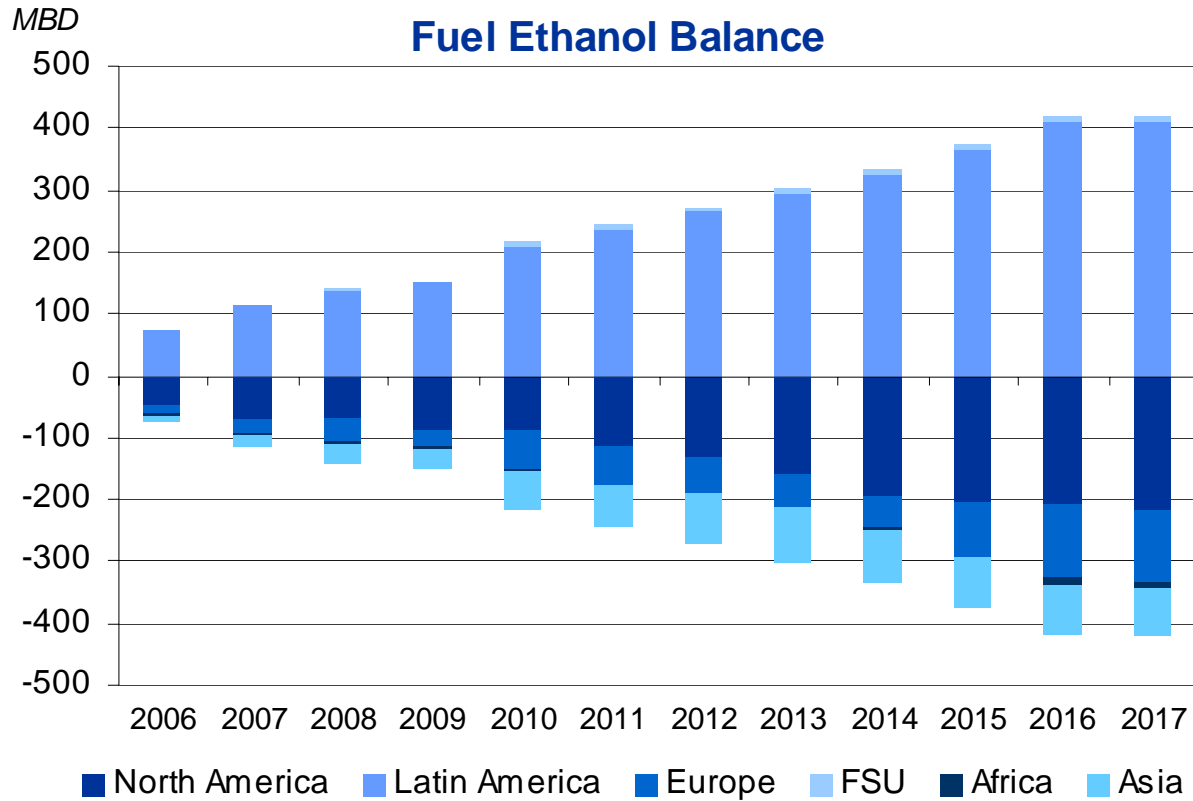
- **Biofuels will constitute 4% of liquids demand by 2020 in this scenario, much higher than the other scenarios**

Worldwide Ethanol Demand Growth



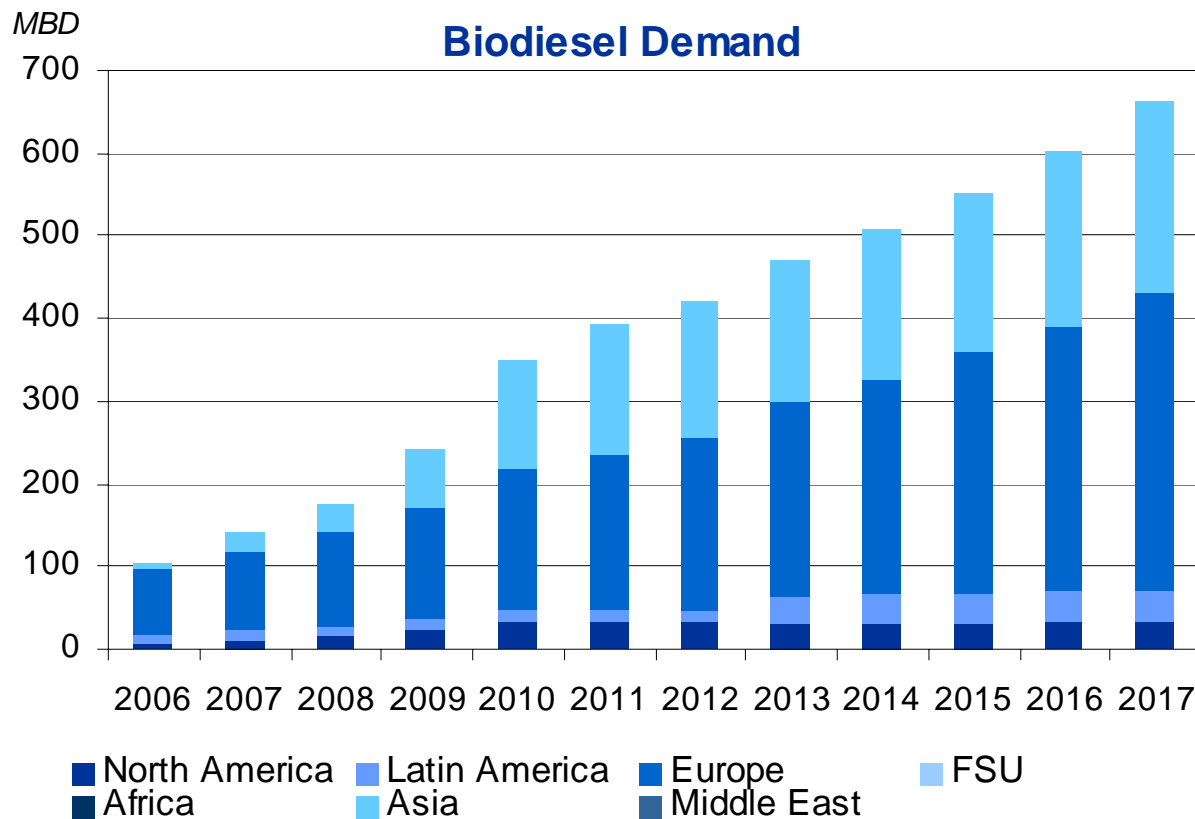
Source: PFC Global Outlook for Biofuels

Fuel Ethanol Balance



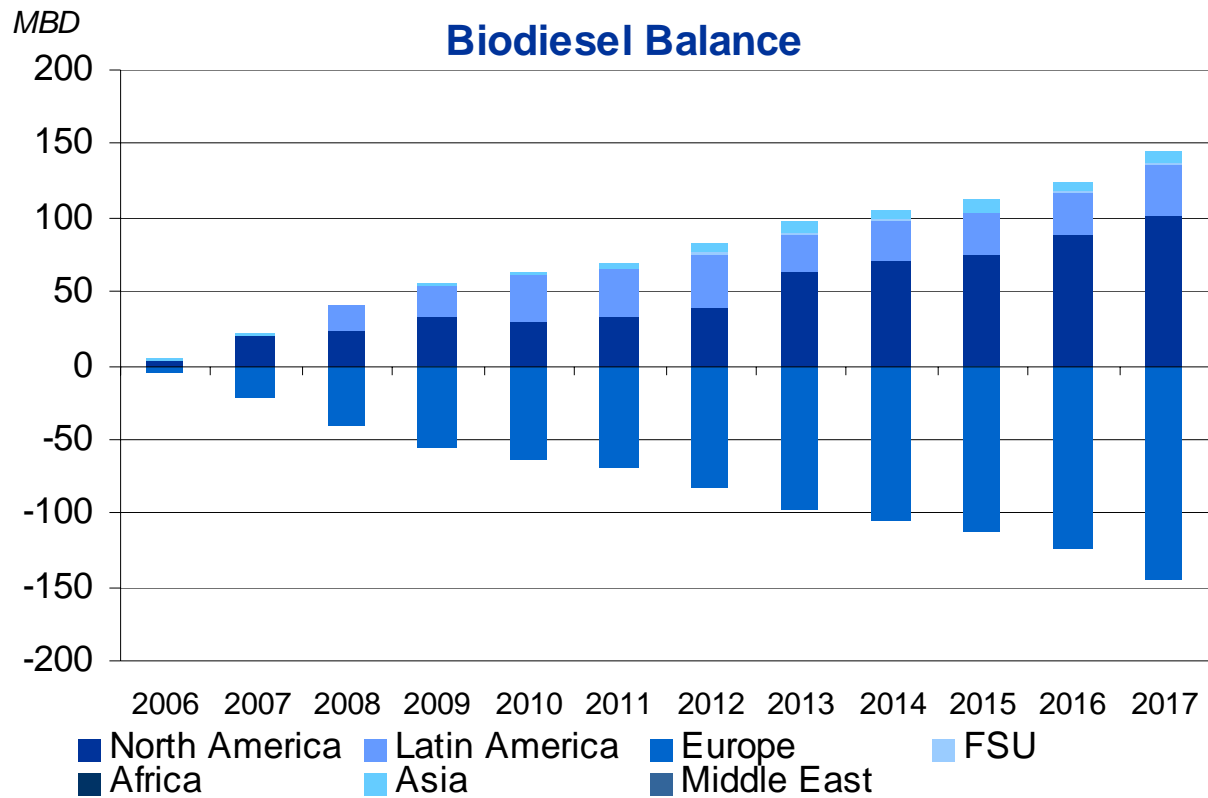
Source: PFC Global Outlook for Biofuels

World Biodiesel Demand Growth



Source: PFC Global Outlook for Biofuels

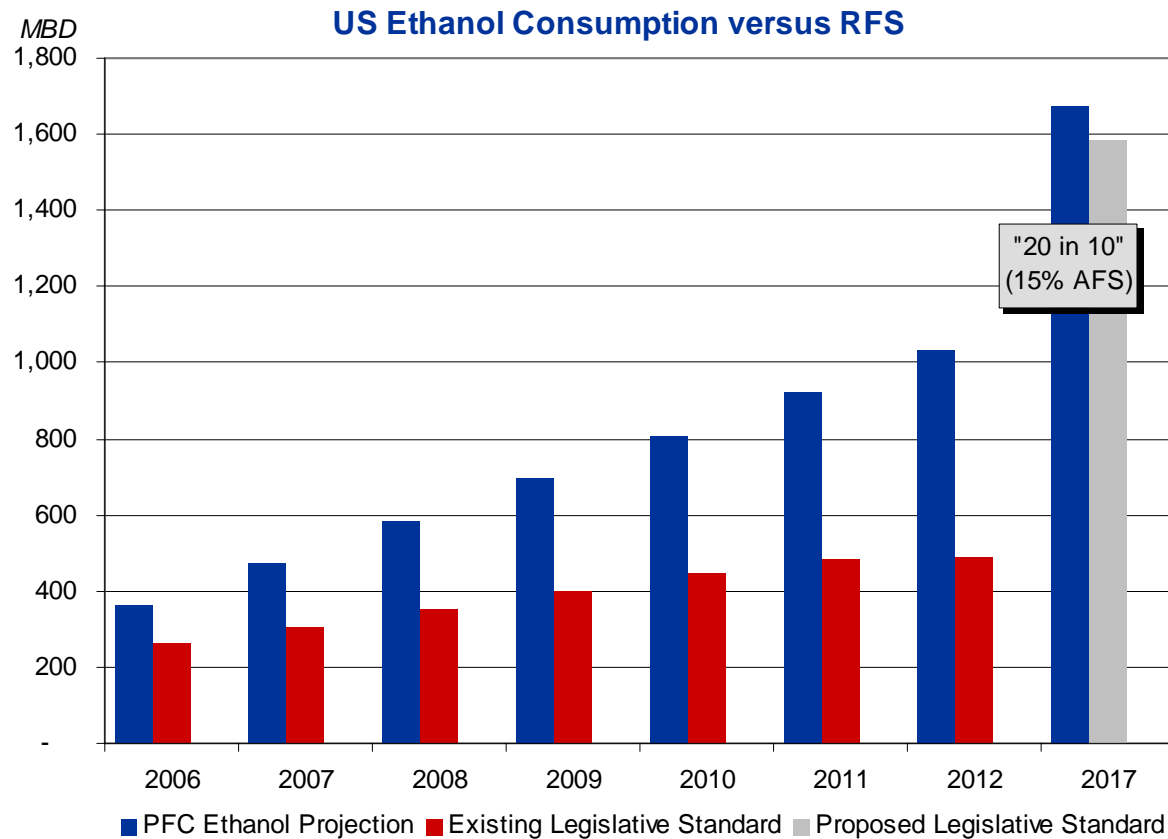
Biodiesel Balance



Source: PFC Global Outlook for Biofuels

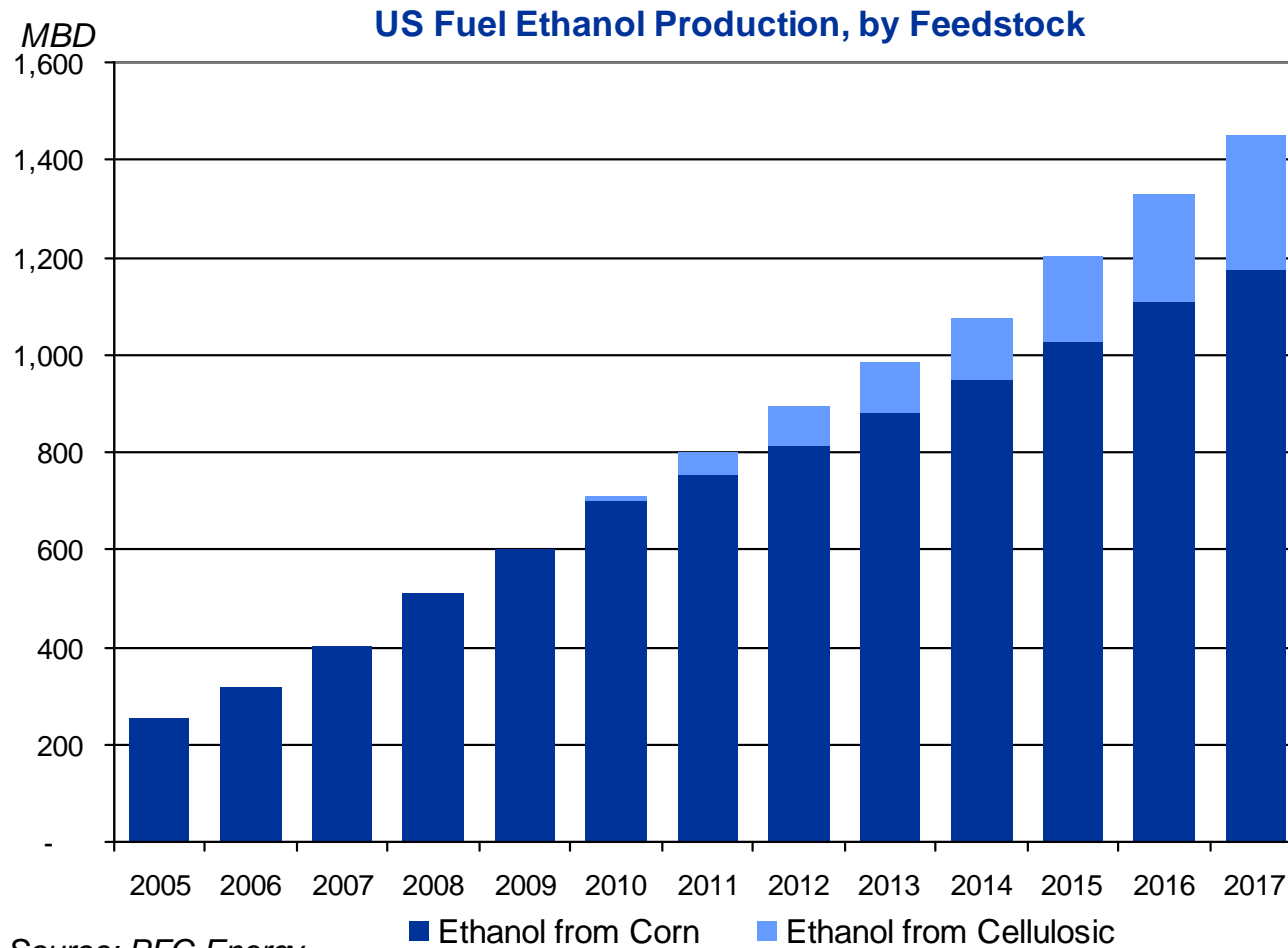
Assessment of the U.S. Experience

Potential US Ethanol Demand Growth



Source: PFC from EIA

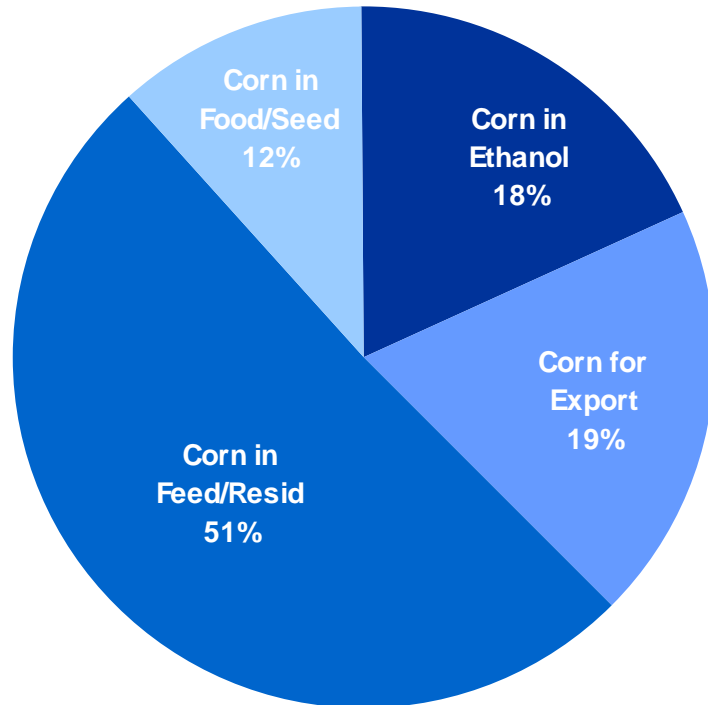
Potential US Ethanol Production Growth



Source: PFC Energy

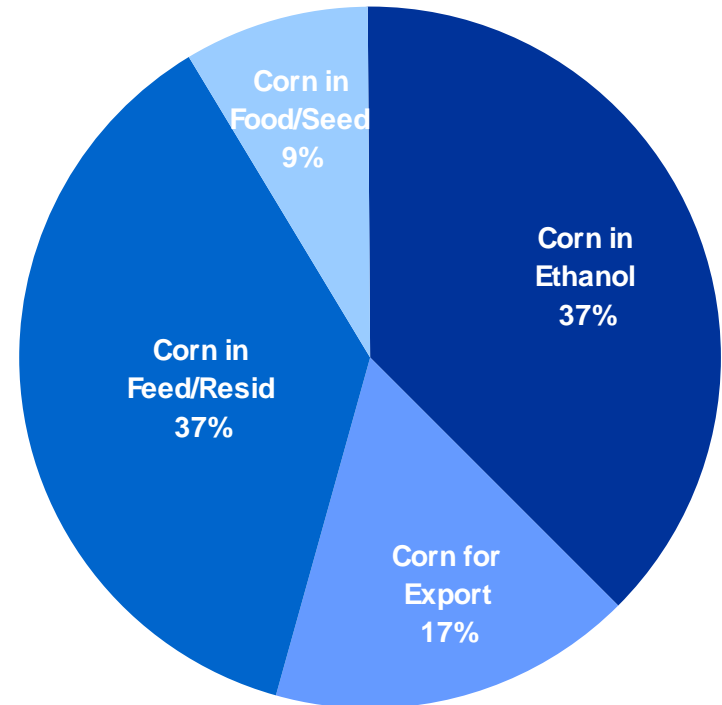
US Corn Feedstock Availability

Corn Usage in 2006



Source: PFC Global Outlook for Biofuels from USDA

Corn Usage in 2017



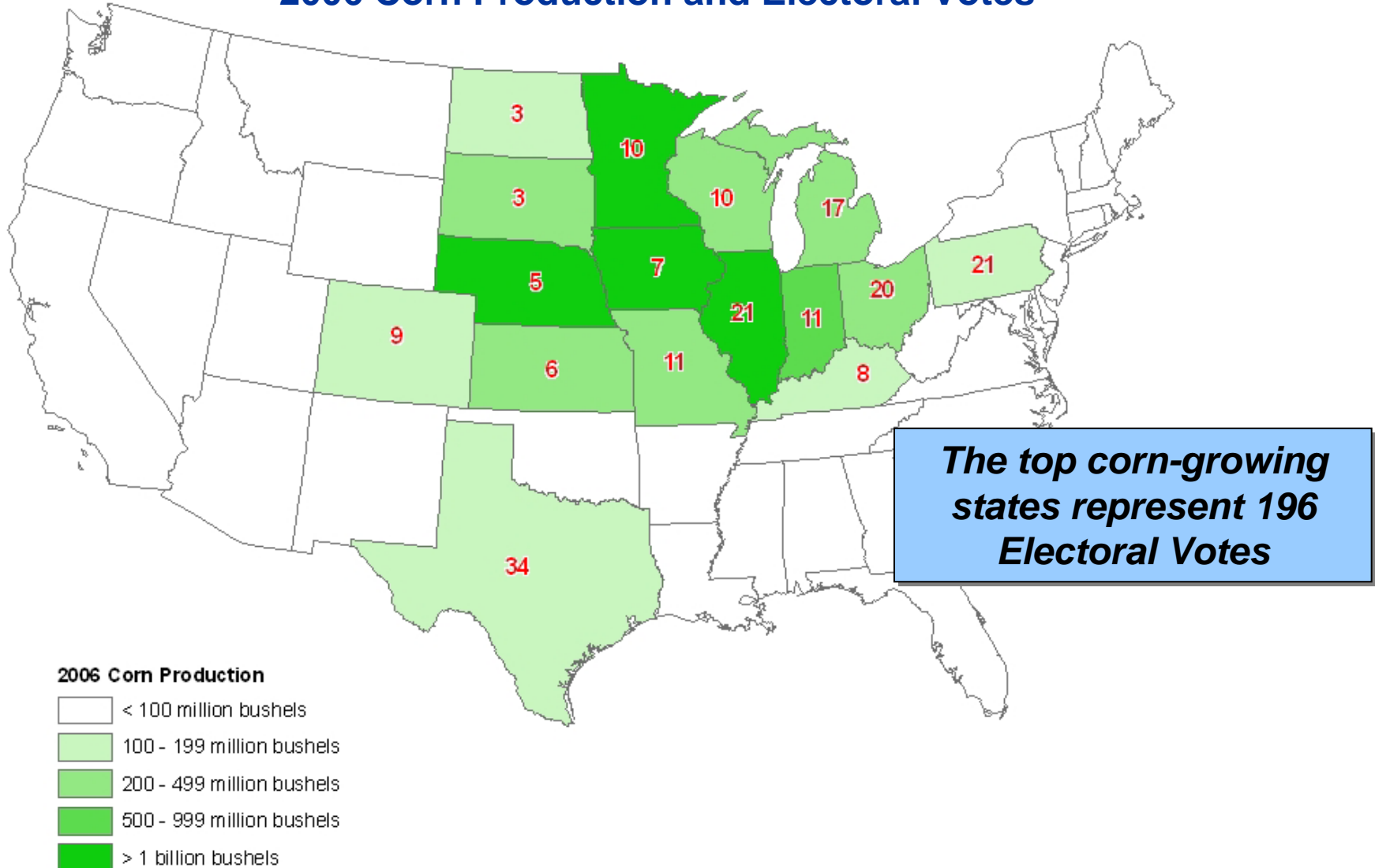
Source: PFC Global Outlook for Biofuels from USDA

Feedstock Assumptions

- 100 million acres in corn production by 2017 (70 million in 2006)
- 160 bushels/acre maximum yield from 2006 yield of 149 bushels/acre
- 1 million acres/year from Reserve/Conservation and minimal shift from soybeans
- Increase of corn exports equal to 10-year average growth rate
- Increase of feed/residual usage equal to half of 10-year average growth rate

Political Support (> 100 million bushels)

2006 Corn Production and Electoral Votes



The top corn-growing states represent 196 Electoral Votes

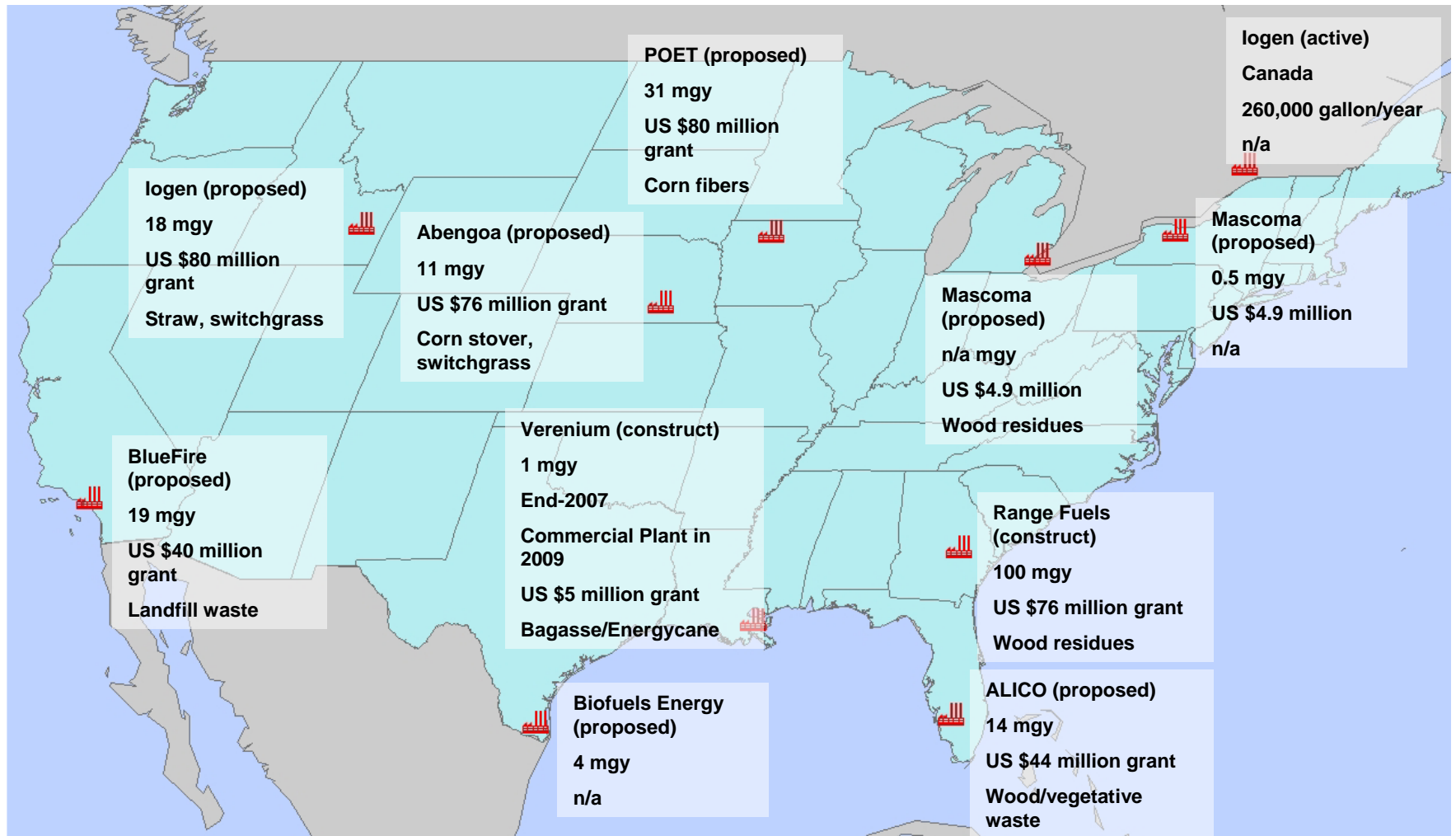
2006 Corn Production

- < 100 million bushels
- 100 - 199 million bushels
- 200 - 499 million bushels
- 500 - 999 million bushels
- > 1 billion bushels

Source: PFC Energy from USDA

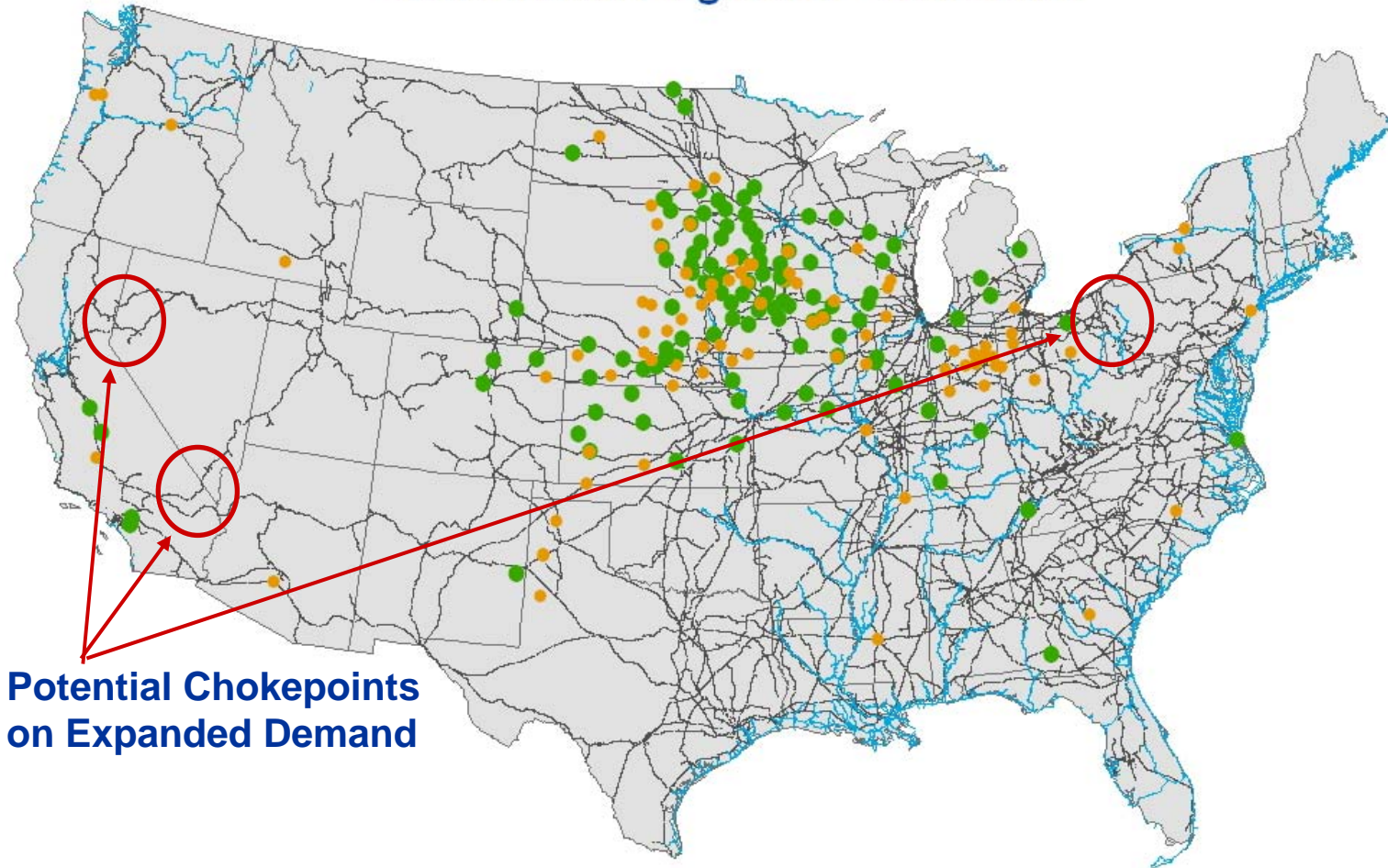
- **The Department of Energy is aiming to lower cellulosic production costs from recent estimates of US \$2.26/gallon to US \$1.00-\$1.10/gallon by 2012**
- **A number of universities run research partnerships with cellulosic development firms as well as the Federal government**
 - July 2007: Xethanol renews partnership (and loans US \$200,000) to Virginia Tech to explore:
 - Steam-explosion for pre-treating biomass
 - Advanced enzymes for hydrolyzing steam-exploded biomass
 - A composite predicative model coupled with economic analysis
 - Scaling up steam explosion, hydrolysis, and fermentation
- **US Department of Agriculture Secretary Mike Johanns:**
 - “Even if you have it in place in, let's say three years, and it's commercially viable, there's still a lead time to build plants, engineer and do all of those things... I do think that it's probably going to be on the outer end of that three- to five-year schedule by the time you factor all of that in.”
- **Senior Advisor to NREL Helena Chum:**
 - “Eventually, by 2012 to 2016, it (cellulosic production costs) should fall to \$1 per gallon, when output should reach 20 billion gallons... 5 billion to 8 billion gallons of that will come from cellulose.”

Demonstration/Research Plants

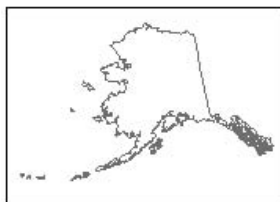


Logistical Bottlenecks

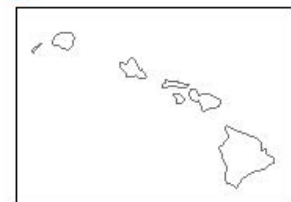
US Ethanol Logistics - end-2006



**Potential Chokepoints
on Expanded Demand**



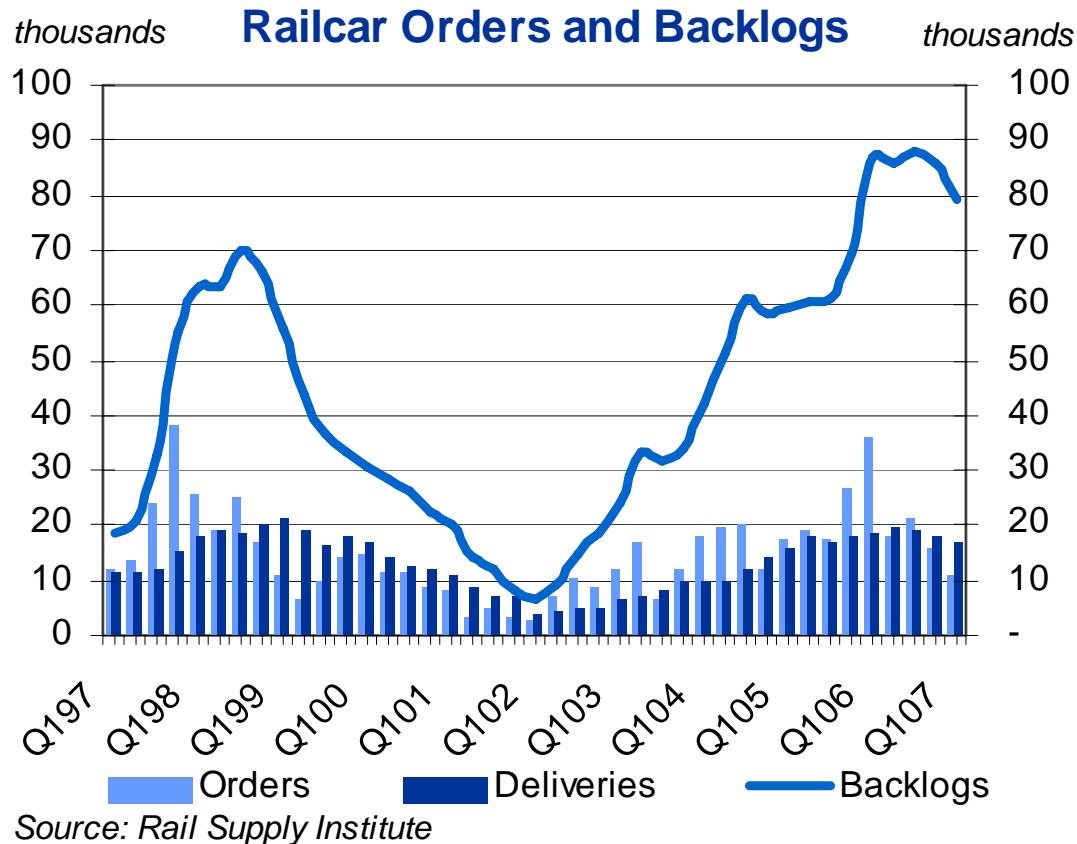
- Active Ethanol Plant
- Inactive Plant (Construction, Expansion)
- Inland Waterway System
- Active Class I Rail



Other Logistical Concerns

- **Chemical properties for anhydrous ethanol currently prevent it from being shipped via pipeline**
 - Hydro-affinity, contaminates other fuels being shipped on the pipeline
 - Phenomenon of stress corrosion cracking not yet fully understood
- **Alternative forms of shipment have their own drawbacks**
 - Barges
 - Winter freezing of commercial waterways, shuts supply in north of St. Louis, MO
 - Limited access to markets distant from major rivers
 - Railways
 - Timeliness dependent upon train availability and cargo manifest
 - Railcar availability (backlog of 85,826 railcars as of 2006)
 - Trucks
 - Limited by distance and capacity
 - Least cost-effective method
- **Terminal infrastructure growing but still small**
 - Ethanol requires dedicated storage tanks
 - Terminal requires train off-loading facilities or dock access

Ethanol Logistics – Tank Railcars



- **Approximately 291,000 tank cars operating at the end of 2006 in North America (GATX 10-K)**
- **Backlogs are at the highest level since the late 1970s when the rail industry was largely deregulated and privatized**

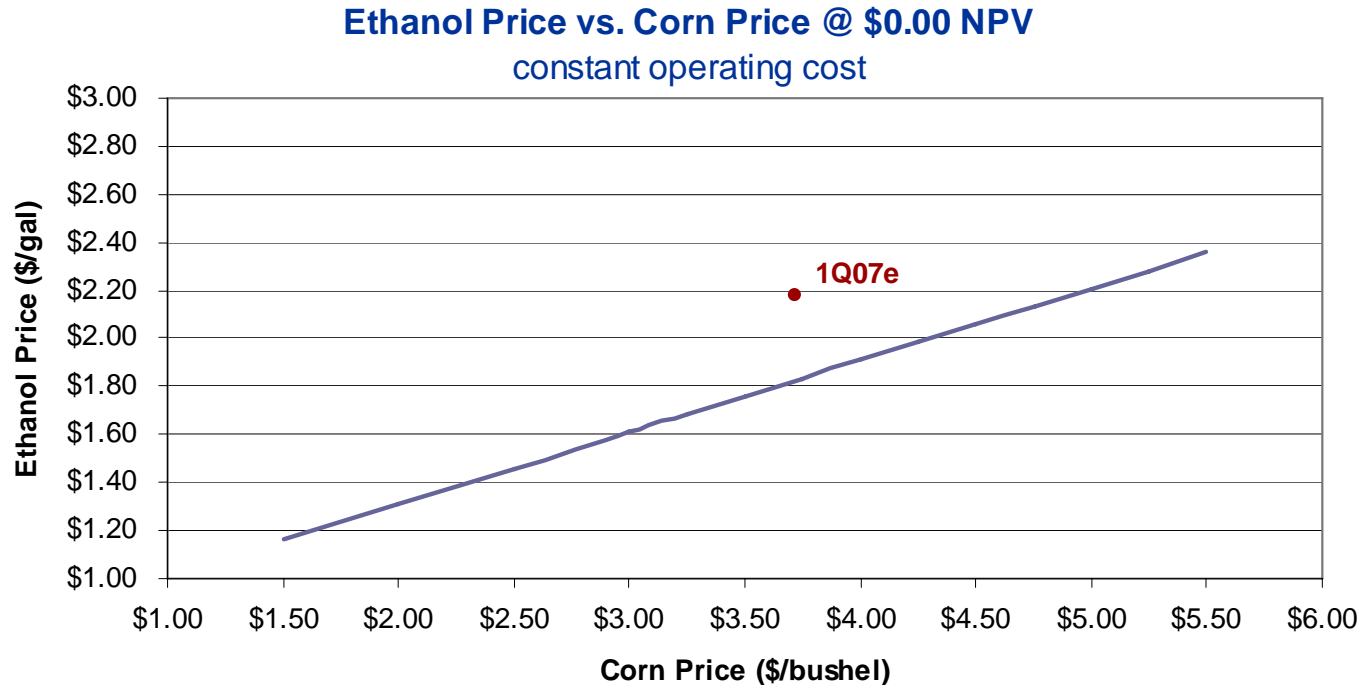
Origin Intermodal Ethanol Hubs

- **Dedicated ethanol storage**
- **Linkage with different transport modes**
 - Truck
 - Rail
 - Barge
- **Terminals planned in Iowa and Missouri**
 - Manly, Iowa on-stream in October 2007
 - Sauget, Missouri on-stream in 2Q08

Primary Destination Terminals (unit-train capacity)

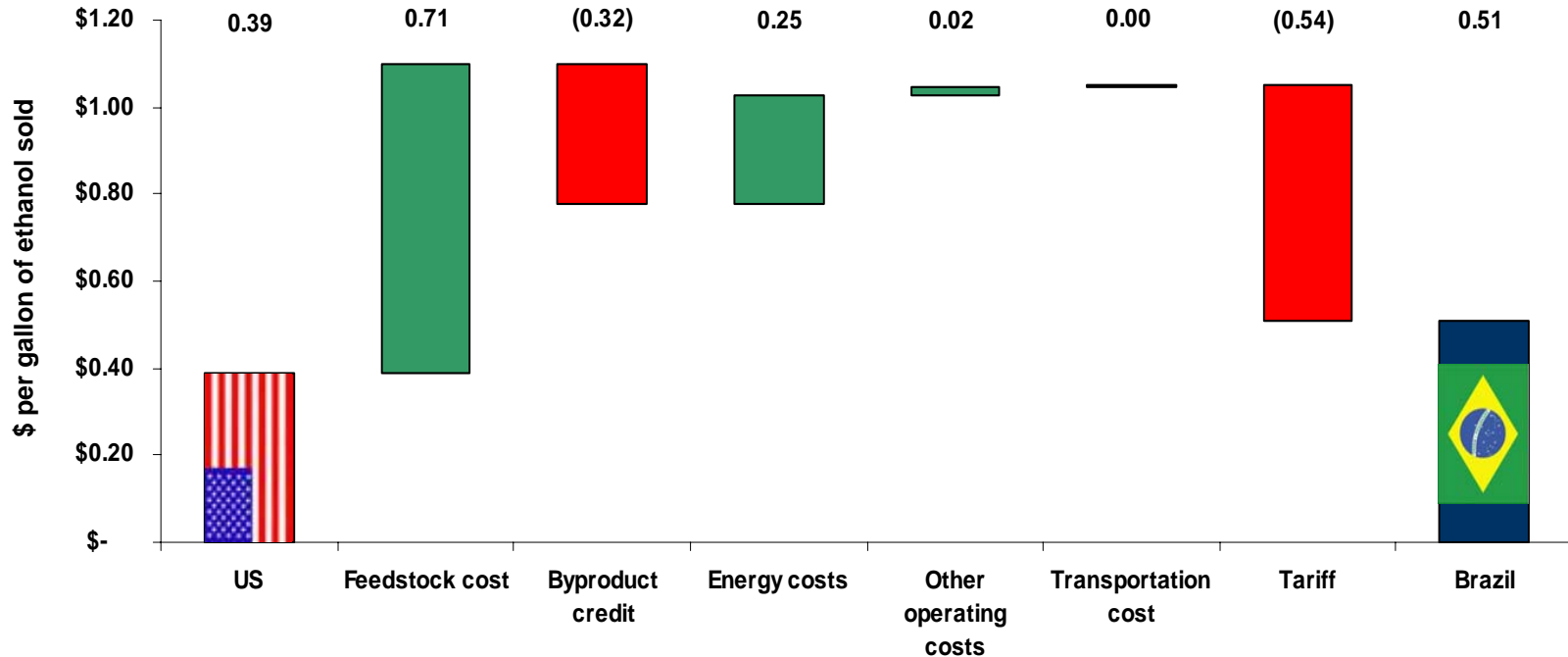
- **Albany, NY (CSX)**
- **Arlington, TX (US Development Group)**
- **Baltimore, MD (US Development Group)**
- **Linden, NJ (US Development Group)**
- **Lomita (Carson), CA (Kinder Morgan)**
- **Sewaren, NJ (Motiva)**
- **Additional Super Hubs proposed for Providence, RI and Stockton, CA**

Economic Horizon – US Dry Mill



- **Excludes \$0.51/gallon federal tax incentive**
- **\$52 MM initial investment**
 - 40 MM gal/yr capacity
 - \$1.30/gal investment
- **15 year project life**
- **Taxes 32%**
- **WACC = 7.7%**
 - Debt/Equity = 60/40
 - Interest rate on debt 7%
 - Required ROE 12%
- **CAPEX to offset depreciation**

Relative Economics – Net Cash Margin



- The typical ethanol producer in Brazil has a comparative advantage in feedstock cost versus the typical US producer through processing sugarcane as opposed to corn
- A partial offset is available via the byproduct from corn, Distillers Dried Grains with Solubles (DDGS), which can be sold for livestock feed...
- ...however Brazil captures a nearly equivalent benefit in energy savings through use of bagasse (sugarcane stalks) as fuel
- Outside the US, Brazil's competitive advantage on margin would be equivalent to \$0.66/gal +/- differences in transportation cost suggesting it would be best positioned to supply importing markets

Global Outlook

- **There is the potential for biofuel volumes to increase significantly**
- **Even so, biofuels will remain a relatively small portion of supply**
- **Growing concerns about energy security will play an important role**
- **Continuation of high oil prices will encourage the development of alternative sources of supply**

US lessons

- **Adequate supply of feedstock is required for expansion**
- **The development of logistics is as important as production capacity**
- **It will be difficult to create a sustainable program...**
- **...without the development of the second-generation technology**



Strategic Advisors in Global Energy

PFC Energy consultants are present in the following locations:

- ▶ Bahrain
- ▶ Beijing
- ▶ Buenos Aires
- ▶ Calgary
- ▶ **Houston**
- ▶ **Kuala Lumpur**
- ▶ Lausanne
- ▶ London
- ▶ Mumbai
- ▶ New York
- ▶ **Paris**
- ▶ San Francisco
- ▶ **Washington, D.C.**

Main regional offices are shown in bold.

www.pfcenergy.com | info@pfcenergy.com

Main regional offices:

▶ **Asia**

Level 9 South Block
Wisma Selangor Dredging
142-A Jalan Ampang
50450 Kuala Lumpur, Malaysia
Tel (60 3) 2168-8870
Fax (60 3) 2161-0702

▶ **Europe**

19 rue du Général Foy
75008 Paris, France
Tel (33 1) 4770-2900
Fax (33 1) 4770-5905

▶ **North America**

1300 Connecticut Avenue, N.W., Suite 800
Washington, D.C. 20036, USA
Tel (1 202) 872-1199
Fax (1 202) 872-1219

4545 Post Oak Place, Suite 312
Houston, Texas 77027-3110, USA
Tel (1 713) 622-4447
Fax (1 713) 622-4448