What Factors Will Determine the Choice of Future Biofuel Feedstocks?

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Today’s Presentation: Setting the Stage for Second Generation Biofuels

I. Examine “first generation” biofuels, mainly ethanol
   – Brief historical review
   – Key policies
   – Ethanol markets and economics

II. Discern possible lessons for cellulosic fuels

III. Identify risk factors
Underlying Drivers Shaping Biofuel Markets

Government Policy

Technology

Oil Prices
Ethanol History Shaped by Markets and Policies
Recent Gains Reflect Shift in California, High Oil Prices, and 2005 Energy Bill

- Early 1900s: Original fuel for the Ford Model T but could not compete with cheaper petroleum and lead additives for engine knock
- 1970’s: reborn with rise of OPEC and spike in energy prices, along with formal government support (exemption from federal excise tax, import tariffs, and various State incentives)
- 1980s: fades as crude oil prices fall
- 1990s: limited role, mainly supported by clean air mandates for reformulated fuel, along with methyl tertiary butyl ether (MTBE), another oxygenate
- By 2004, California, the largest gasoline State, started to blend 5.7 percent ethanol after its request for a waiver from oxygenated fuel use was denied
- Smooth logistics of moving ethanol from the Midwest to a coastal State paved the way for further growth
- Prompted by soaring oil prices, the 2005 law mandated 7.5 bil. gal. by 2012, but more importantly, removed liability protection for MTBE, which polluted groundwater
New Energy Bill Mandated Ethanol Use Will Exceed 10 Percent of Gasoline Use by 2013 *

- New mandate rises to 35 billion gallons by 2022 *
- Ten percent ethanol blend is maximum under current vehicle warranties
- U.S. gasoline use was 142 billion gallons in 2007
- Assumed annual future growth of 1.0 percent in gas use results in ethanol demand of 16 billion gallons by 2022, compared with 35 billion gallons mandated
- Additional ethanol use will have to come from flexible fuel (E-85) vehicles or change in engine warranties to allow higher than 10-percent blend

* Assumes total renewable fuel mandate of 36 billion gallons minus 1 billion gallons for biodiesel
Rise in Ethanol Price Triggered Investment Boom
But Also Contributed to Higher Feedstock Prices and More Volatility

- Policy umbrella accompanied by dramatic spike in ethanol price unleashed a flood of investments
- The surge in ‘green’ investments and venture capital has also been accompanied by investor and speculative buying of commodities as an asset class
- Volatility in crop markets has increased sharply, also reflecting global tightness in wheat and robust demand for food because of strong income growth
Ethanol Margins Slipped This Fall But Generally Remained Positive

Corn Cash Price DTN National Index
Monthly Average, Aug 2006-Jan 2008

Estimated Ethanol Monthly Margins
Aug 2006-Jan 2008
Biodiesel Margins Fall Sharply as Soybean Oil Prices Soar

Soybean Oil Price CBT Adjusted for Basis
Aug 2006-Feb 2008

Estimated Biodiesel Margins
Discretionary Market

Per gallon

$ per pound

$0.20
$0.25
$0.30
$0.35
$0.40
$0.45
$0.50
$0.55
$0.60
$0.65

8/1/2006
11/1/2006
2/1/2007
5/1/2007
8/1/2007
11/1/2007
2/1/2008

$1.50
$1.00
$0.50
$0.00
-0.50
-1.00

8/1/2006
11/1/2006
2/1/2007
5/1/2007
8/1/2007
11/1/2007
2/1/2008
Location is One Disadvantage for Corn Ethanol
Potential Cellulosic Feedstocks Closer to Fuel Demand

- California is the largest gas-consuming state, followed by Texas, Florida, and NY
- Only 2 Corn Belt states in the top ten: Illinois fifth and Ohio sixth
- Largest demand is in Southeast, Northeast, and West and augurs well for alternative feed stocks, given long distances and lack of pipelines to move ethanol from Midwest to coasts
- However, decentralized alternatives must be weighed against economies of scale issues
Plants Can Afford High Corn Prices If Ethanol Price Stays High Enough

- At current corn price of $4.75 per bushel and $2.20 ethanol price, margins are about $0.35 a gallon
- At ethanol price of $2.20 per gallon, estimated break even point is $5.95 per bushel
- At $4.75 corn, break even price of ethanol price is $1.86
- Revenue from distillers grain by-products is significant
- Distillers prices have been rising in tandem with corn—lower DDG prices could weaken margins
- Plants have potential to tap corn oil as another revenue source if vegetable oil prices stay high
Ethanol’s Price Premium to Gasoline Is Shrinking

- With production well over mandated use, falling prices in 2007 stimulated more discretionary blending
- Huge near-term expansion of ethanol production and infrastructure limitations may lead to a buyers market, at least temporarily
- Price is also influenced by mandates and regional supply/demand imbalances
- If ethanol consistently gets priced at discount to gas, margins could turn negative, especially in a weaker oil market
Weak Economic Growth Slows Energy Demand
High Prices Tend to Slow Gasoline Use

Annual Growth in U.S. Gasoline Use, 1950-2007
Advantages of Using Corn As a Feedstock For Ethanol

- Corn has a record of strong productivity gains due to huge investment in genetics and equipment, now mostly by private sector
- Investment incentives for private sector research: huge acreage, annual purchase of hybrid seed and other inputs, technology boost to margins, and frequent equipment upgrades
- Unrivalled harvesting, storage, and distribution system
- Established grades and standards, end-user familiarity, and massive economies of scale
- Pricing and risk management system for producers and end-users
- Just-in-time delivery model—little or no storage costs for corn
- Corn Belt plants have abundant local supplies while unit trains can supply non-Corn Belt plants
What Factors Will Make New Feedstocks Commercially Viable?

• Assured feedstock supply: need to attract growers for the energy crop or guarantee a reliable flow of other biomass
• Efficient logistics for harvesting, delivery, and storage
• Develop a market with price discovery and risk management or provide alternatives such as contracting
• By-product to generate additional revenue or to trim costs, such as burning the by-product to help power the plant
• Profit opportunities for plants to attract investment
• Avoid running up the price--like soybean oil--to make biofuel production uneconomic
• Allow startup time to build feedstock supplies
Biofuel Risk Factors: Oil Prices

Current outlook is uncertain: expectations for weaker economic growth are counterbalanced by geopolitical concerns and speculative price push

• A decline in oil prices will likely mean lower ethanol prices
• As recently as 1998, oil fell to $10 barrel in the wake of the Asian financial crisis.
• Demand Side Wildcards
  – Consumer squeeze/recession
  – More conservation
  – Vehicle technology/mpg improvements
• Supply Side Wildcards
  – Lagged response to strong price signals begins to increase supply
  – Calming of political hot spots
  – Blockbuster new energy discoveries
Biofuel Risk Factors: Government Policy

- Response to changing markets could lead to unknown policy change
- 2005 Energy Bill only lasted 27 months
- What if the policy criteria or objectives change?
  - More focus on water use
  - Refine carbon rules
  - View of energy independence widened to include fertilizer
  - Restrictions on land use
- If ethanol import tariff expires on schedule (Jan. 1, 2009), cheaper imports from Brazil could compete in coastal markets
- Pressure mounts from higher food costs
- Subsidy and/or mandate adjustments
Biofuel Risk Factors: Technology

- Unpredictable developments can change the game: for example, the DVD makes the videocassette obsolete or cell phones do an end-around land-line phones
- Competing fuels breakthroughs:
  - Improved engine performance for diesel, and more substitution for gasoline, as in Europe
  - Plug-in hybrids drawing from the electric grid
  - Improvements in battery technology
  - Butanol
  - Fuel cells/hydrogen vehicles
Appendix
Until Recently, Agricultural and Energy Prices Had Virtually No Relationship in Post-WWII Era

**Crude Oil Price vs. Corn Price, 1949-2008**

- **Per bushel**: $0.00 to $5.00
- **Per barrel**: $0 to $90

**Key Points**:
- Crude oil and corn prices show a significant increase from the 1980s onwards.
- There is a notable divergence in price trends between the two commodities post-1980.
- The diagram illustrates the rise in prices, with corn and oil prices both reaching high levels in the early 2000s and beyond.
2007 Energy Bill Raises the Mandate
“Advanced” Biofuels to Augment and Then Surpass Corn

Applicable Volumes of Renewable Fuel (Billions of Gallons)

<table>
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<th>Calendar Year</th>
<th>Non Corn Starch Ethanol, Biogas, Butanol, Biomass</th>
<th>+Biodiesel</th>
<th>+ Cellulosic Biofuel</th>
<th>= Total Advanced Biofuels</th>
<th>+ Corn Starch Ethanol</th>
<th>=Total Renewable Fuel</th>
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<td>0.25</td>
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Secretaries of Energy and Agriculture will determine applicable volumes for calendar years not specified in the table.
New Energy Bill Raises Renewable Fuel Mandate for Corn-Starch Ethanol

New Mandate vs. USDA Long-Term Ethanol Baseline Projections (Pre-Energy Bill)