

An Update on Biofuel Source Developments*

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Abstract

With demand expected to continue to grow, the U.S. Congress along with energy planners and entrepreneurs have turned in part to biofuels as an alternative source of energy. The initial focus in the U.S. has been primarily on corn as a biomass source, since supplies had been plentiful, Midwest farm states and the U.S. Department of Agriculture (USDA) have historically promoted new uses of corn, and corn fermentation to ethanol was thought to represent a quick approach for rapidly altering U.S. dependence on foreign oil. Corn could be used as fuel if foreign sources of oil were curtailed.

Another driver in the movement to promote biofuels according to the International Energy Agency of the Organization for Economic Cooperation and Development (IEA), has been the belief that climate change has been triggered by the increased atmospheric concentrations of greenhouse gases as a result of the combustion of “non-renewable” sources of energy (IEA, 2006). Using biomass for fuels essentially recycles carbon dioxide from the atmosphere rather than releasing new carbon from fossil fuels.

Corn starch, soy oil and palm oil may not represent the best biomass sources for biofuels as their use is perceived to be “robbing” using prime farmland, rain forests, and agricultural sources of food. This paper identifies factors to consider in selecting and developing “ideal” biofuels and reviews alternative sources under development. The authors report on the progress of leading candidates for the biorefinery of the near future, including development of perennial cellulose sources and microalgae.



An Update on Biofuel Source Developments

April 2011 AAPG Annual Convention

by Richard Bost

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Introduction and Scientific Proof

Drivers for Investments in Biofuels & Biomass

Alternative BioMass Sources

Alternative Technologies

Moving Forward

The future ain't what is used to be" - Yogi Berra.

Introduction-

The future ain't what is used to be" - Yogi Berra.

Nothing could be more true in energy and the environment. *Who would have expected \$100-150 per barrel oil.*

Oil will be here for a long time, but everyday newspapers are promoting biofuels and other renewable, alternative energy sources.

Environmental and sustainability issues are no longer limited to environmentalist causes and affect investor investment decisions.

Biofuels are NOT the “silver bullet”; but their use reduces need for infrastructure investments for electric, natural gas or hydrogen fueled vehicles. But biofuels have their challenges as do all alternatives.

THERE ARE A LOT OF MIXED SIGNALS IN THE MARKET PLACE

Climate Change – The Tipping Point

Tipping Point Occurred in 1996 as Corporate CEOs of Major Oil Companies and others joined effort of investing in Biofuel Research and other Alternative Energy developments.





Delivering sustainable solutions in a more competitive world

BioFuels Industry

Projected Growth Attracts Investors

Biofuel revenues are projected to grow to \$81 billion by 2017. Key issue for growth is ability to switch to a non-food based feedstock.

Production is predicted to expand from 7 billion gallons in 2003 to 15.6 billion last year and to 45 billion gallons per year by 2017.

Some predict more rapid growth with government policies that reduce infrastructure costs.

Source: Clean Energy Trends-Clean Edge, 2008.



Why Biofuels at All?

Increased Energy Demand

Security of Supply

Government Support of Farm Industry

Climate Change

Food v Energy and Sustainability Issues

Driver: Huge Increase in Global Energy Demand

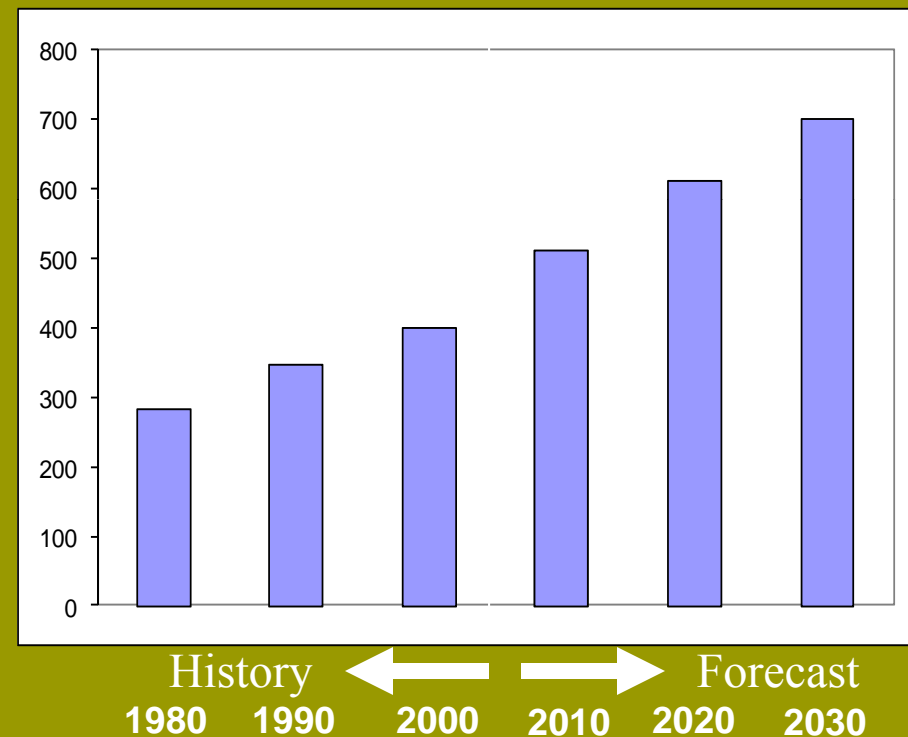
Dangerous Currents?

Population and economic growth in developing countries is driving demand. By 2030 fossil fuel consumption is predicted to double from pre-2000 levels to support demand. Some believe oil reserves have peaked.

Climate change and growing demand, given uncertain oil supplies in politically unstable countries, are driving investors to look at alternative energy solutions.

Annual Demand

Quadrillion BTU



Source: International Energy Administration

Driver: Global Energy Demand

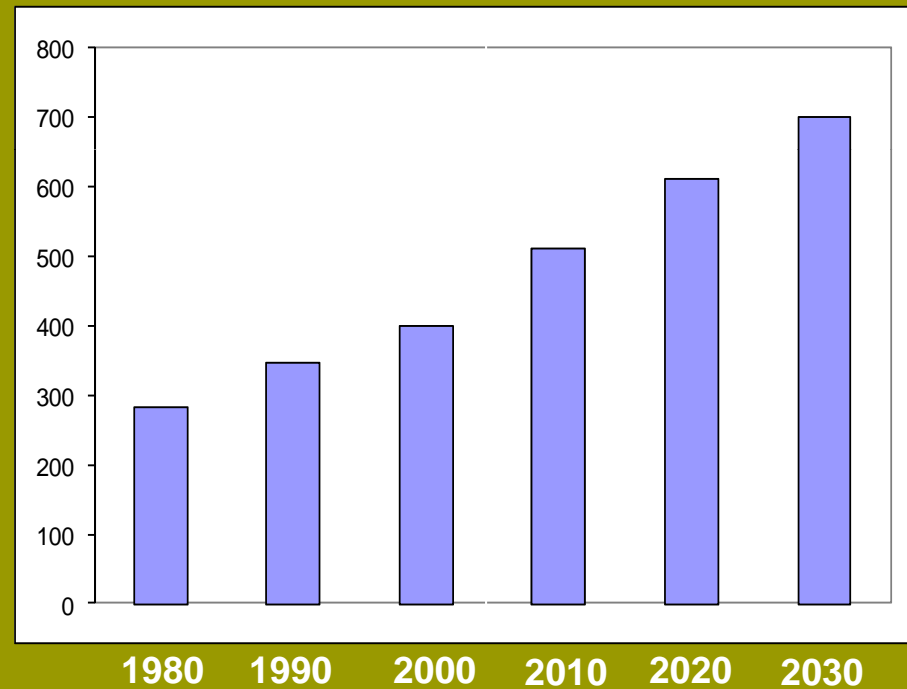
Limitations in Supplies affect Economic Security

Economic concerns and security issues play a role. Oil price spikes significantly impact world economies.

1973-1975 recession was largely caused by the Arab Embargo. The 1980 recession was caused by the Iranian revolution. 1990-1991 recession is tied to Iraq's invasion of Kuwait.

New oil in a well-functioning market can grow to meet demand but most prospects are located in areas of political unrest. Alternative energies are being promoted for national security reasons (as well as political reasons).

Quadrillion BTU



Source: International Energy Administration

Driver: Security of Supply

Lessening our Dependence is a Valid Objective

Energy independence and security are the buzz words of Washington.

Non-OPEC producers and global oil companies have not been able to step up production significantly despite recent high prices raising the Peak Oil debate. In 2010 we imported over 60% of our fossil fuel needs.

Nationalism, e.g. in Russia and Venezuela, combined with Middle East and Africa instabilities drive investors elsewhere.

(While independence from imported oil is a strong topic of discussion, the “hard truth” is that foreign oil will continue to play a significant role in meeting our energy requirements for quite some time.)

Driver: Federal Decisions & Government Policies

Carbon Dioxide concentrations exceed 380 ppm, higher than in geologically discernible history. Oil companies are engaged in shaping Government Policies worldwide.

Environmental Regulation. New Movement in US: 2007 US Supreme Court ruled USEPA must address the regulation of Greenhouse gas under Clean Air Act—expected to encourage use of biofuels.

Greenhouse Gas Emissions “inventory” reporting rules going into effect worldwide. Transparency is driving companies to reduce emissions and identify plans in Corporate Reports.

US Renewable Portfolio Standards for refineries. Requiring increased percentages from renewable sources.

Biofuel mandates for fuel blenders and retailers. Mandates for transportation fuel blenders to add biofuel in many countries.

Driver: Biofuel Sustainability Issues

Investor & Consumer Buying. Worldwide public has awakened to the issue of sustainability and investors see great opportunities in biofuel and biomass industries, yet:

Food v Fuel Debate. *Co-op America* reports that the corn required for 25 gallons of ethanol can feed a person for a year.

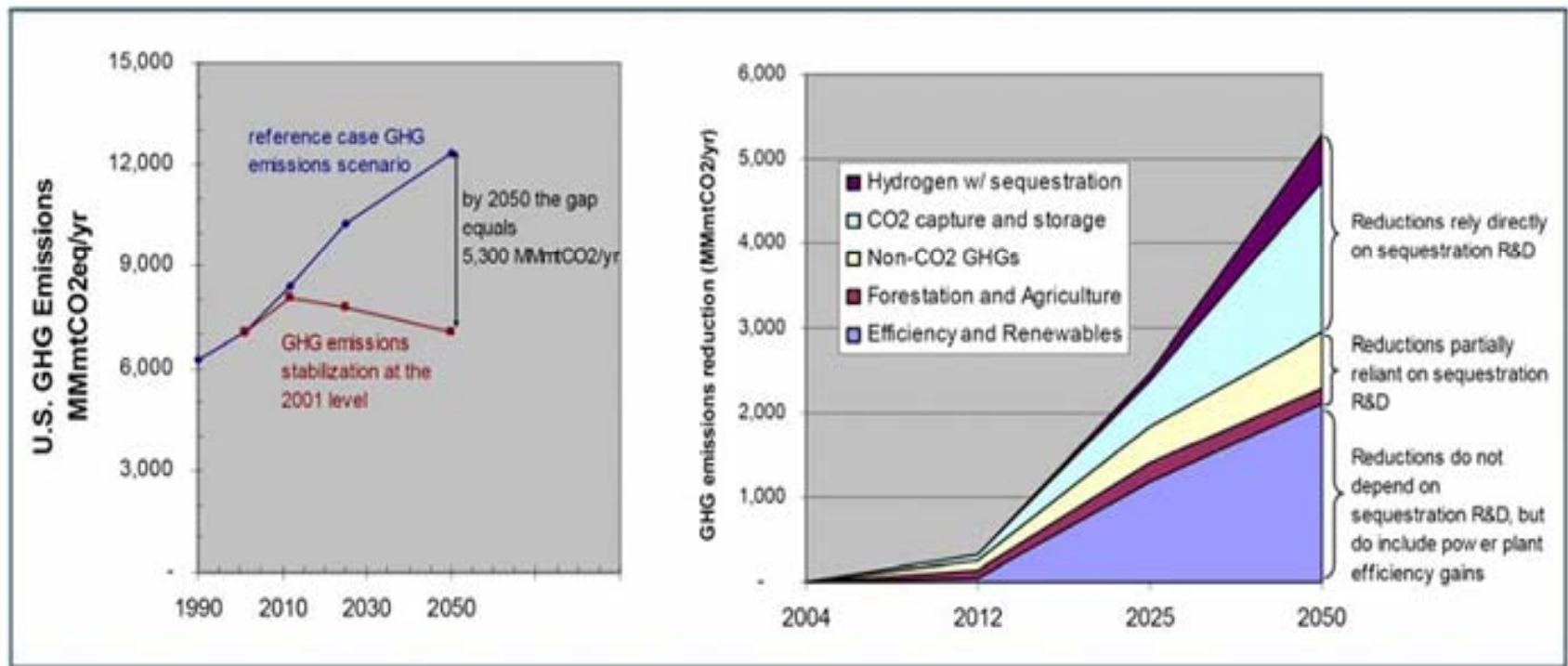
Food vs Fuel is blamed for increases in world food prices.

Rainforest Destruction. Issues related to palm oil for biodiesel and destruction of rainforests is affecting investor decisions.

Sugar cane expansion in Brazil is also of concern.

Carbon “Footprint”. Net energy gain and carbon emissions related to corn, cellulose & other biofuel yields are issues.

US Driver: Climate Change and U.S. Carbon Policy



Source: NETL, 2004a.

- Legal challenges and future cost of Carbon Capture and Sequestration is limiting coal.
- Alternative biomass sources for fuels and efficiencies of competing technologies and which will ultimately be practical is up in the air.
- Need to understand lifecycle secondary impacts on carbon footprint. Ethanol from corn may not be best alternative, if technological developments do not occur.
- Stern Report indicated a significant impact on GDP of developed countries if we wait.

Global Clean Energy

2010 Revenue and Investment

2010 revenue growth for biofuels slowed relative to growth for solar and wind. All increased despite global recession. Biofuel growth has been dominated by ethanol based on sugar cane (Brazil) and corn (US).

New investments in energy technologies - including VC, project finance, public markets, and research and development - have expanded to over \$200 billion annually.

VCs in the U.S. invested over \$5 billion. Clean energy indices outpaced broader markets.

**Estimated Revenue
Billion Dollars**

Source Clean Edge

Competing Alternatives Are Drawing Investors

BioMass Sources

- Corn, sugar, wheat, soy, palm oil, waste vegetable oils, animal oils, lipids from micro-algae
- Cellulosic sources: wood chips, grass clippings, biosolids, bagasse, corn stover; switchgrass, jatropha, malva & castor crops

Alternative Technologies

- Fermentation
 - Advanced enzymes or unique enzyme sources, such as termite stomach bacteria
- Gasification and catalysis
- Advanced micro-algal production & esterization methods

What is Best Alternative? Usual Business Criteria for Growth Investments

Viable business plan and economics

Adequate capitalization

Protection of intellectual property

Proven and/or scalable technology

Proven and knowledgeable management

Favorable market conditions

What is Best Biomass Source for Biofuels? It Depends on Future Developments

“If we knew what it was we were doing, it would not be called research, would it?” --Albert Einstein

Additional Criteria for Biofuels Investments

Sustainable BioMass Source criteria:

- Need a reliable source that
 - 1. Is or can be plentiful
 - 2. Requires minimal processing
 - 3. Does not switch use of prime farmland away from food (or feed) crops
 - 4. Is a waste biomass or an alternative crop not used for food
 - 5. Is a perennial crop requiring minimal tilling
 - 6. Is characterized by high yields per acre of land
 - 7. Does not promote conversion of rainforests for agricultural production

Additional Criteria for Biofuels

A business strategy that

- 1. Reduces the cost and energy of
 - agricultural production,
 - transportation and
 - production and
- 2. Is characterized by a smaller carbon “footprint”.

Additional Criteria for Biofuels

A technology platform that

- 1. Is proven and can be demonstrated commercially
- 2. Has high biomass conversion and fuel yield
- 3. Has low energy demand
- 4. Requires less infrastructure development
- 5. Yields a fuel that meets current or expected future fuel specifications (without fungibility, drying & gumming issues)

A description of an Ideal BioFuel Investment

For immediate needs, the Ideal BioFuel must “fit” into the economic, environmental and existing infrastructure

- a. Does not compete with food stocks (or food crop agricultural land),
- b. Is sustainable and ecofriendly.
- c. Processing of biomass is practical in terms of economics, scale, and ease of technical stretch.
- d. Yields a fuel that is fungible into the distribution infrastructure and product structure, can be delivered economically and can be scaled up to make an impact.

What this probably means for BioFuel Source Developments – Need Sourcing that

- a. Utilizes waste biomass or alternative crop grown on marginal farmland as a source for bioethanol and biodiesel
- b. Takes advantage of patented advanced enzyme technologies or gasification/catalysts
- c. Is produced proximate to biomass source and terminal/refinery to reduce transportation costs
- d. Entails less capital and less energy than competing alternatives
- e. Can be promoted as a sustainable source of energy

Some Believe Ideal Concept is a BioRefinery

Probably first suggested by Charles Abbas of ADM

Recognizes potential income from creating a mixture of products

A more complex, yet flexible and optimized facility may be able to take advantage of economics of multiple products and mixed feed stocks.

Investment interest in biorefinery near a blender or oil refinery that utilizes a nearby reliable biomass source with tailored enzymes that captures CO₂ from fermentation to enhance micro-algal biodiesel yields.

2010 Bio Ethanol Source Developments

Corn Prices and economics have inhibited US industry.

Sugar cane movement as expanded with announcements such as Shell-Cosan, Petrobras and KL Energy Deals.

Canadians investing in municipal waste to biofuel facilities; US investments in same stymied.

Woody biomass investments surged while ag-waste residues slowed in investments.

2010 Bio Diesel Source Developments

Palm oil continued to grow despite sustainability concerns with deforestation for palm groves.

Algae yields could be > 40% but is not yet commercial.

Soybean oil has risen as a US alternative.

2010 BioAlgae Research Grows But Not Commercial

2010 Saw More Investments in Algae Research But Challenges Prevent Commercialization

- Energy cost of circulating algal solutions
- Contamination of algae cultures
- Biomass extraction for use

Conclusions re The Future

Political Stability Issues are affecting Investment Decisions.

Energy yield and Economics of Ethanol production from corn and rising commodity and food prices are driving demand for new feed stocks.

Biodiesel use remains low and will struggle without new feed stocks.

The impact of food issues and the environmental and carbon impacts of renewables will affect investment decisions and governmental policies.

A change in world government policies has promoted but could also discourage different biofuel options.

Changes in fuel standards and biofuel quality will affect demand.

Biofuel technology developments and government policies are needed for biofuels to grow in use worldwide.