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# BIOFUELS REPORT: MARKET REALITIES, PERSPECTIVES AND CHALLENGES

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# INTRODUCTION

**Biofuels come of age as conditions spur demand**

The world doesn't often collectively agree on anything; however, there are not many dissenting voices advocating abandonment of the quest to seek biotechnology-driven alternatives to gasoline and diesel for running automobiles and other transportation vehicles.

Biofuels are, in comparison to fossil fuels, more environmentally friendly in production and consumption stages and will eventually be much less expensive than their petroleum counterparts.

Biofuels exploration involves planting and harvesting crops or using byproducts and waste materials for feedstock to generate the manufacturing process. The refinement process entails building block component separation techniques that extract or create biofuels like ethanol and biodiesel.

That compares favorably to the messy, hazardous and expensive oil refinement method of drilling into the earth's core to extract raw crude oil, transporting it great distances across fragile ecological systems, then burning the raw crude in some of the most dangerous man-made environments on the planet: oil refineries and chemical plants.

These factors contribute to the perception that biofuels is a logical, and necessary, understudy-in-waiting to replace gasoline, which is definitely going through an image crisis.

When automobile inventor Henry Ford designed the Model T Ford in 1908, it was built to run on alcohol, which was touted as "the fuel of the future" for automobiles and other vehicles. The gasoline industry has delayed that projection for almost a century, but the time for biofuels may have finally come, amidst concerns over increasing gas prices, dependency on relationships with sometimes not-so-friendly oil-producing nations and the high costs of extracting and refining domestic crude oil.

Renewed interest in gasoline alternatives was jumpstarted during the oil crisis in the 1970s and has most recently been fortified by events of the past decade.

During the past four decades there has been a growing interest in the U.S. and other major nations in developing alternative energy fuel sources that are cleaner, more cost-efficient, and are capable of being widely accessible to a broad range of consumers.

During the past few years, as issues in the Middle East have caused instability in the price of oil and concerns over oil's negative impact on the environment have arisen, the U.S. and other leading nations have intensified their efforts to develop biofuels into a major market power. Ethanol has emerged as the key biofuel for production and has become more economical to produce and more cost effective to consume than gasoline.

American companies have also developed vehicles and vehicle modification equipment that allow most newer cars to use E85, a fuel source that is 85 percent ethanol and 15 percent gasoline, while all American cars can currently run on E10.

Biofuels is certainly a progressive alternative to the dangerous, costly and depletive ransom mankind pays to power its vehicles with gasoline and diesel products, but there are still some important factors that are prohibiting the proliferation of the biofuels industry right now, as well as implicating its future.

There may not be a preponderance of voices speaking out against the manufacturing of biofuels, but there are still challenges to think about as the biofuels bandwagon gathers supporters and horsepower on the road in its quest to become the primary fuel source in the U.S., as well as the rest of the industrialized world.

Demand, economic impact and opportunity in the U.S. continue to increase, as consumers, bureaucrats and venture capitalists seek to optimize benefit from the technology.

With the U.S. leading the way, numerous acts of legislation are encouraging biofuels ventures by facilitating the process to grow feed sources, build biorefineries, sell biofuels, manufacture and convert bio-friendly vehicles and purchase the products.

U.S. President George W. Bush recently stated he intends to accelerate his alternative-energy agenda during the remainder of his term with new spending aimed at eliminating bottlenecks that are slowing the spread of ethanol in the market.

Other leaders of many progressive nations have voiced similar intentions to encourage biofuel ventures.

Such moves have resulted in an increase over the last nine years of U.S. gas stations selling ethanol, going from 77 in 1997 to more than 1,000 in 2006. That is a dramatic increase, but since there are more than 170,000 service stations in the nation, it shows there is a lot of ground to cover before the product is considered truly accessible to the general population.

*Joint efforts energize across industries*

In August 2006, a convergence of science and energy was implemented to realize the commercialization of a line of biofuels products. DuPont and BP plc announced the creation of a partnership to develop, produce and market a next-generation portfolio of biofuels to address increasing worldwide demand for alternative fuels.

DuPont and BP have been working together since 2003 to develop advanced biofuels with elements that attend to the restrictions of existing biofuels technologies. That project has developed to the position where a marketed product is imminent.

The companies are utilizing DuPont's biotechnology and bio-manufacturing competence with and BP's fuels technology experience to develop advanced biofuels that would aid in the mission to comprise 30 percent of the world's transportation fuel market within the next quarter-century.

The first product from their joint efforts will be biobutanol, which is on schedule to reach the consumer market in 2007 in the UK as a gasoline bio-component. DuPont and BP are working with British Sugar, a subsidiary of Associated British Foods plc, to convert the nation's first ethanol fermentation facility to produce biobutanol. And plans are underway to begin construction of an even larger such biorefinery in the UK.

Biobutanol addresses some of the issues that have hampered the widespread production and market permeation of biofuels. The product emits low vapor pressure, has more tolerance to co-existence with water contamination in gasoline mixtures and has the capability to be blended into gasoline at higher concentrations than existing biofuels. Those characteristics allow its use in existing gasoline supplies and distribution venues without the need to retrofit vehicles, pipelines and storage facilities. Biobutanol also produces superior fuel economy compared to gasoline-ethanol blends.

BP's interest in biofuels has been shown in other activity also. In June 2006, it became the first fully integrated energy company to become a member of the Biotechnology Industry Organization (BIO), which is the largest biotechnology trade and interest and lobbyist organization in the world, representing the interests of more than 1,100 biotechnology companies, academic institutions, state biotechnology centers and related organizations across the U.S. and 31 other nations.

BP's venture in biofuels also includes a $500 million investment to found an Energy Biosciences Institute, with a mission to develop advanced commercial alternatives to oil and gas. The company has also decreed inclusion of E10 at its gasoline service stations throughout the world and is also involved in the production of ethanol.

*Additional partnerships predict merging market borders*
Iogen Corp., located in Ottawa, Canada, was the first company to supply a sizeable amount of cellulosic ethanol to the commercial market when it sold 1,300 gallons to a Petro-Canada refinery.

Iogen's potential in cellulosic biofuels has also drawn the financial support of one of the giant oil companies in its program to develop an alternative fuel to compete with gasoline.

In November 2002, Royal Dutch Shell plc, based in the Hague, Netherlands, partnered with Iogen as a development collaborator in biofuel technology.

Royal Dutch Shell has invested C$46 million in Iogen to engage in cooperative research to develop and commercialize cellulosic ethanol and has increasingly taken to the path of renewable energy in a number of its programs and actions, potentially giving an indication of the future plans of Big Oil to immerse itself in the biofuels market.

The oil company, much like many of its gasoline-providing counterparts such as ExxonMobil and BP, dropped the word "oil" from its name years ago in a trend that has left the industry with less descriptive monikers to remind an oft-aggravated public of the business they are in.

Royal Dutch Shell, on its website, describes itself as a global bloc of oil, gas and petrochemical companies with an expansive range of hydrogen, biofuels, wind and solar power interests, as well as a goal of meeting the energy requirements of the world, in ways that are economically, socially and environmentally sustainable. None of that sounds like gasoline or oil products, but does invoke a vivid image of biofuels.

Royal Dutch Shell also has entered into an agreement with Choren Industries GmbH, of Freiberg, Germany, to build a biomass-to-liquids plant, indicative of the increasing trend of Big Oil interest and participation in the second generation of biofuels: cellulosic ethanol.

Cellulosic ethanol production on a substantial enough scale to meet a significant amount of the U.S. or world demand is at least a decade way from reality, and such serious investment by the oil companies may be a sign that they are willing to show the patience to make the long-term type of risk investment that shows confidence in a developing technology with a potentially successful future such as biofuels.

Chevron Corp. is another oil company with various interests in biofuels. It formed a new biofuels business unit that will pursue commercial ethanol and biodiesel production and distribution opportunities in the U.S., and is involved in several research projects with the U.S. Energy Department.

Perhaps that is why Big Oil is not so immediately worried about being run out the market by the latest upstart.

Since ethanol initially topped the 1 billion gallon mark for annual production in the U.S. in 1992 with 1.1 billion gallons, it has advanced to increase its production value by what is expected to be approximately 400 percent by the end of 2006, to around 4.3 billion gallons.

Yes, this is progress, but is put into perspective when considering that in the U.S. alone, gasoline is being consumed at an annual rate of 145 billion gallons.

**Projected U.S. Fuel Ethanol Production, 2006-2012**

| Year | Production (in billions of gallons) |
|---|---|
| 2006 | 4.3 |
| 2007 | 4.9 |
| 2008 | 5.6 |
| 2009 | 6.2 |
| 2010 | 7.0 |
| 2011 | 7.9 |
| 2012 | 9.0 |

Source: BioWorld research.

The ethanol market, with generally casual financial support and erratic administrative and public attention paid to it since OPEC's oil embargo in 1973, has nevertheless gone from a near nil market to a 22 billion valuation in 2006, according to BioWorld calculations.

That market appraisal includes the current next-to-negligible impact of the cellulosic biofuels sector, but not any contribution from the biodiesel market.

Ethanol is the market placeholder today, cellulosic ethanol represents the evolution of the technology into the immediate future (six to 40 years) and biohydrogen is the ultimate in transportation fuel trilogy that could, in effect, render gasoline obsolete in the mid- to late-21st century.

**Ethanol Revenue Market Forecast, 2006-2012**

| Year | Revenue (in billions of dollars) |
|---|---|
| 2006 | 22.1 |
| 2007 | 24.4 |
| 2008 | 26.3 |
| 2009 | 31.6 |
| 2010 | 34.9 |
| 2011 | 35.7 |
| 2012 | 39.3 |

Source: BioWorld research.

The U.S. Department of Energy has estimated that ethanol from cellulosic biomass has the potential to replace up to 30 percent of U.S. gasoline demand by 2030, and the Natural Resources Defense Council estimates that cellulosic biomass ethanol could replace 50 percent or more of U.S. demand by 2050.

That 50 percent goal would be an effective plateau to reach, but if it really takes a half-century to reach that juncture, the world's addiction to oil by then may have become a terminal overdose.

Without a significant innovation in cellulosic ethanol, the biofuels market is likely to falter, or at least lack the pace necessary to satisfy a significant percentage of demand, inasmuch as corn cannot conceivably handle the displacement of gasoline in the U.S. anymore than crop-based ethanol can keep pace with global gasoline consumption without running out of steam.

A BioWorld forecast projects similar incremental cellulosic biomass ethanol market progress. Based on current models and trends in legislative, investment and production dynamics, BioWorld estimates the market for cellulosic biomass ethanol, currently a research-stage market with negligible return to-date, to have a production value of 20 billion gallons annually in 2020.

Designating a negligible return to-date does not signify a valueless market, rather a literal ground-floor venture opportunity to participate in inaugural and probable returns in a product and market that stand to redefine, and maybe inherit, or at the very least share, a stake in the market for transportation engine fuel, one of the biggest revenue-generating industries in history.

Oil has rarely failed to deliver return on investment and has frequently dropped the collective public jaw with periodic announcements of stratospheric record profits that keep redefining the “Top 10” list of record quarterly profits for publicly traded companies.

Any product that could be blended into, or even replace, gasoline as the fuel of choice for the millions of automobiles in use on the roads, stands to share or inherit immense market share.

**Ethanol Volume Potential**

| State | Millions of gallons/year* |
|---|---|
| Alabama | 263 |
| Alaska | 46 |
| Arizona | 277 |
| Arkansas | 149 |
| California | 1,592 |
| Colorado | 218 |
| Connecticut | 186 |
| Delaware | 43 |
| Florida | 855 |
| Georgia | 511 |
| Hawaii | 110 |
| Idaho | 65 |
| Illinois | 531 |
| Indiana | 318 |
| Iowa | 167 |
| Kansas | 137 |
| Kentucky | 234 |
| Louisiana | 242 |
| Maine | 72 |
| Maryland | 286 |
| Massachusetts | 289 |
| Michigan | 504 |
| Minnesota | 277 |
| Mississippi | 168 |
| Missouri | 330 |
| Montana | 51 |
| Nebraska | 88 |
| Nevada | 303 |
| New Hampshire | 73 |
| New Jersey | 439 |
| New Mexico | 99 |
| New York | 583 |
| North Carolina | 447 |
| North Dakota | 37 |
| Ohio | 534 |
| Oklahoma | 193 |
| Oregon | 156 |
| Pennsylvania | 530 |
| Rhode Island | 39 |
| South Carolina | 261 |
| South Dakota | 44 |
| Tennessee | 312 |
| Texas | 1,169 |
| Utah | 107 |
| Vermont | 36 |
| Virginia | 402 |
| Washington | 274 |
| West Virginia | 86 |
| Wisconsin | 262 |
| Wyoming | 35 |

*Based on 10 percent blend of 2004 volume
Source: The *ACE Ethanol Handbook*, published by the American Coalition for Ethanol (ACE).

Consumers want price relief and are not particular about which product delivers it. In the unlikely event that retail gasoline prices fall back to $1.25 per gallon, public concern would probably decrease, as it

has historically in response to such events, and biofuels would likely suffer from indifferent market and public attention similar to that of past periods when respite from gas pump increases deferred public alternative fuels agendas and distracted public concern. Likewise, biofuels, or any other alternative product capable of relieving or usurping the monopolistic stranglehold gasoline has on society, can enjoy instant market regard and success.

**Stage is already set for fuel replacements**

It is a plus that the various forms of ethanol have entered the market, not only as standalone products, but in blends with such a market stalwart as gasoline. It is the equivalent of having a number one television show as your primetime lead-in, or breaking into the National Basketball Association as a rookie with the world champions.

The groundwork and opportunity to benefit and prosper are already laid out, as transportation fuel is one of the primary staples of modern society. Gasoline, a commodity subject to evoking distrust, distain or a wide range of skeptical regard, is nevertheless one of the most consistently profitable, analyst-approved and necessary products in the world.

Any product poised to become heir to that position stands to acquire immediate market recognition and the traditionally corresponding benefit of a gainful market share.

BioWorld concludes from applicable research that the inventory of discovered oil with capabilities of being processed, represents a supply of approximately 45 years. Undiscovered and difficult-to-access oil fields could provide between 25 to 50 additional years of supply; however, estimates paint an encroachingly dire picture for worldwide oil supply and consequent environmental impact that would reach an apex between mid-and late-21st century.

In addition to necessity created by diminishing supply, the world is calling for biofuels for a myriad of other reasons. Fuel alternatives to gasoline are seemingly wanted, needed and endorsed by all relative public, government and private sectors. The most apposite challenges to the emergence of the biofuels market would more than likely be internal breakdowns such as research setbacks, feedstock procurement or feedstock transportation logistics, rather than external factors

**Projected Worldwide Oil Consumption**

| Year | Oil (Millions of barrels/day) |
|---|---|
| 2005 | 83.4 |
| 2010 | 89.6 |
| 2015 | 95.7 |
| 2020 | 104.1 |
| 2025 | 115.1 |

Source: BioWorld research.

such as regulatory roadblocks, investor disinclination, international conflicts or general public opposition.

The biofuels market is unique, in that its progress is less likely to encounter the conventional opposition that traditionally confronts similar fuels markets over concerns such as emissions and other environmentally intrusive issues.

The challenges facing the biofuels market should not be underestimated though. If the biggest challenges continue to be serious, though not-quite market-killing issues, such as finding a way to produce more corn, converting dispensable biomass to commodity-grade fuel, and pre-process and post-refining transportation of respective feedstock and product, the biofuels market will likely experience progressively consistent growth and apt return on a scale that has the potential to rival the oil industry at its peak.

**Big Oil involvement and impact**

The exception to that apparent external concord could be the continued fair-play compliance of the oil companies in a market that seeks to overhaul their very own heretofore incontrovertible dominance, as well as the impact of more portentous challenges, such as war and precarious international relationships, confronting that industry on a daily basis.

Among the predominant challenges facing the emergence and validation of the biofuels industry is the conformity and involvement of Big Oil in merging its attention to incorporate the old with the new.

The role of the indomitable oil industry, which has persevered and managed through all challenges to its dominion over the transportation fuels market for more than a century, will change, but not likely be significantly diminished or compromised.

Its position as an ultimate entity in a mega-market, crucial to the overall stability and vitality of global economics, actually stands to be strengthened by its participation in the development of alternative fuels to co-exist, and even compete, with the fossil fuel stalwart product.

A conceivable glance into the future will likely offer a revised concept of the influential oil giants as something along the lines of “fuels” companies, encompassing gasoline-derivative and biofuels technology products.

The oil companies will not abandon gasoline, unless it is driven out of market relevance by the cleaner, cheaper and safer bioproducts. That is an eventually reasonable scenario for the latter 21st century, but assuredly, Big Oil will have developed a Plan B long before that.