

BIOWORLD®

BIOFUELS REPORT:
LANE-CHANGING TRENDS
AND FORK-IN-THE-ROAD
DYNAMICS

THE BIOWORLD® BIOFUELS REPORT: LANE-CHANGING TRENDS AND FORK-IN-THE-ROAD DYNAMICS

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BIO WORLD[®]

ANALYSIS

Biofuels Renaissance Seeks to Fill Tanks, as Well as Hopes

The latest, and most committed to date, biofuels renaissance began in Europe around 2000, when countries turned their attention to the implementation of various alternative transportation fuel initiatives that sought to address and alleviate the environmental, cost and national security issues that were tied to the production of gasoline. Throughout the decade, various events and situations such as wars, acts of terrorism, natural disasters and touchy relationships have ignited flames that repeatedly have triggered disruptive disorder in the oil market.

The biofuels agenda was resurrected in the U.S. in the mid-2000s and has continued to be sustained by a series of events that include the tsunami of negative public reactions to a couple of periods in which the price of gasoline abruptly increased to averages that lingered above \$4 per gallon; several increases in oil barrel prices that went as high as \$147; and the mandate of the Renewable Fuel Standard. Later in the decade, several other countries, including India and China, joined the movement with strategies intended to reduce pollution, energy dependence and the cost of driving, in anticipation of robust growth in their domestic economies.

A gradually worsening global economy that eventually bruised, crashed or destroyed some of the world's biggest companies, prominent market sectors and most developed countries before culminating in a prolonged recession, also has helped to keep the biofuels issue fresh on everyone's mind. The ongoing economic crisis has kept the world attuned to the real and projected disasters

that come as a bonus with every gallon of gasoline sold. Additionally, listening to the oil companies announce record earnings with an "it's not our fault" rejoinder, during the worst economic time since the Great Depression, can also provoke the public to seek "anyone but *them*" solutions to their transportation fuel problem.

Unlike the 1973 birth and past resurrections of interest in biofuels, the current movement has remained in high gear going forward all through the decade, buoyed by the most resolute and active government support the market has ever experienced. In the past, public outrage and government assurances have ebbed and flowed correspondingly with the price of oil, usually abating when spiking gasoline prices stabilize at a level that people decide is "the best we can expect." Heading into 2010, the biofuels industry trends reveal record highs in pro-

European Ethanol Production

(In million litres)

Country	2008	2007	2006	2005	2004
France	950	539	293	144	101
Germany	581	394	431	165	25
Spain	346	348	396	303	254
Poland	200	155	161	64	48
Hungary	150	30	34	35	
Slovakia	94	30			
Austria	89	15			
Sweden	78	70	140	153	71
Czech Rep.	76	33	15		
UK	75	20			
Italy	60	60	78	8	
Belgium	51				
Finland	50			13	3
Lithuania	21	20	18	8	
Latvia	15	18	12	12	12
Ireland	10	7			
Netherlands	9	14	15	8	14
Total	2,855	1,803	1,608	913	528

SOURCE: European Bioethanol Fuel Association.

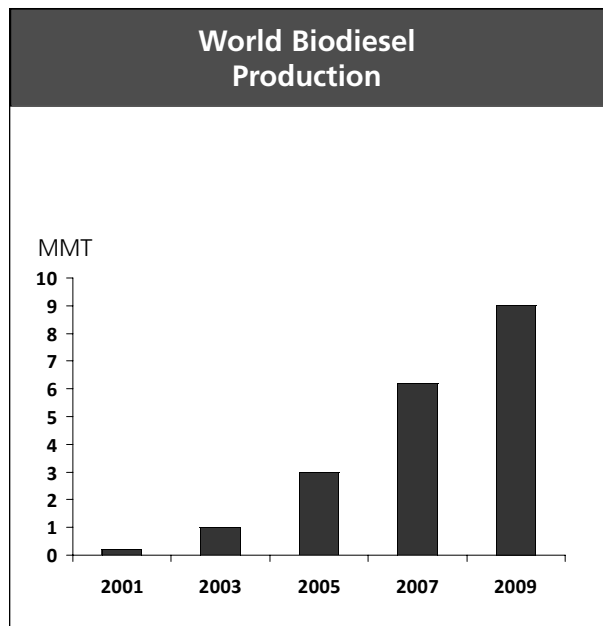
duction, funding and program implementation, along with a global groundswell of advocacy from a faction comprised of all walks of life, from individuals to grassroots to international legislative bodies.

Biofuels, asleep at the wheel for much of the twentieth century, finally could be sufficiently inclined and postured — and abetted for the first time by the opportune union of public, legislative, partnering and venture support — to complete the trip to global market relevance.

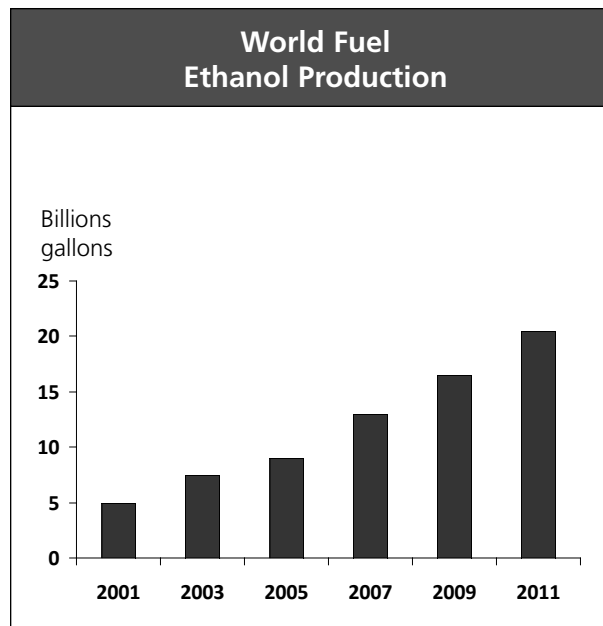
Although the widespread support for biofuels technology seems nearly unanimous, there are still challenges that are keeping its eventual success in doubt. Prevailing trends in the biofuels sector also include downbeat indicators that have impeded the market’s progress in the past and some others that could be hazard signs for the future.

It is generally assumed that some type of eco-tastrophe awaits if we continue to indefinitely rely on fossil fuels. Biofuels is one of the hero technology markets in which we keep our faith, but not yet one we can put our certainty into ... like we can gasoline. The application of biofuels as a market of global utility is still just a vapor. So far, the industry just doesn’t have answers to the questions of ensuring the mass production of its technology. Proponents say we can achieve the goals established by the Renewable Fuel Standard, the European Union Directive and other agendas that call for 30 percent to 50 percent replacement of petroleum fuels by biofuels over the next 30-50 years. But for all the optimism and calculated models, no one is close to proving it can be done.

Biofuels Market Growth



SOURCE: Industry estimates from Bunge Ltd.



SOURCE: Bunge Ltd., citing FO Licht.

Estimated Cost per Barrel of Fuel

Feedstock	Estimated Cost
Jatropha	\$43
Sugar cane	\$45
Corn	\$83
Sugar beets	\$100
Soybeans	\$122
Rapeseed	\$125
Wheat	\$125
Cellulose	\$305

SOURCE: *The Wall Street Journal*, citing Goldman Sachs.

Theoretical Ethanol Yields

Feedstock	Theoretical yield*
Corn grain	124.4
Mixed paper	116.2
Corn stover	113.0
Bagasse	111.5
Rice straw	109.9
Hardwood sawdust	100.8
Cotton gin trash	56.8
Forest thinnings	81.5

*Gallons per dry ton of feedstock

SOURCE: U.S. Department of Energy, Biomass Program.

Biofuels' other predominant challenge is not so much finding a feedstock that has the reserve or the renewability to satisfy long-term global demand, as it is to continuously and efficiently process that feedstock into cellulosic fuel. This is what the biofuels market is up against.

The Success of Biofuels Depends on Big Oil

There are many benchmark factors that are in the process of forging the destiny of the biofuels market, but in the end, the oil industry, which started out as the enemy, is morphing into a partner. The oil industry will wind up as the proprietor of at least a significant portion of the alternative transportation fuels market, and is positioning itself to be the ultimate metric.

But it may not be as bad as you might think to have the There's-Just-Something-Fishy-There conglomerate in charge of the market that everyone wants to believe in. Ironic ... maybe, but sinister? ... not necessarily.

I know we are talking about the dubiously regarded oil industry, whose image, to many, is perceived as some variation of greedy barons who flaunt the profits and wealth they acquired from overcharging a helpless public for the environmentally ruinous product they manufacture. As the majority of civilization wallows in the despair of recession, few will be eager to hear about another windfall opportunity for oil tycoons; however, a Big Oil cooption of the biofuels market might just be the octane boost that biofuels needs to tune up its R&D agenda for a successful market run. After all, no other market comes to mind in being as successful in the face of invariable scrutiny, competition, distrust and restrictive legislation as the oil industry. Biofuels could use some of that resolve, ingenuity and revenue that developed and sustains the House That Oil Built.

Biofuels needs a No. 1 driver and Big Oil has been around the track a few times and has the trillion dollar revenue to prove it. Adversity and criticism do not onerously faze the oil producers. In fact, very little has fazed them over the past 100 years, while biofuels have been pondering a new technology and switching directions every few years in searching for a commercially viable feed-

VENTURE CAPITAL INVESTMENTS IN ALTERNATIVE FUELS AFFECTED BY ECONOMIC DOWNTURN

Cleantech remains a key area of focus for VCs due to government initiatives, advances in technologies and a growing consumer demand for renewable energy. The 2009 Global Venture Capital Survey by Deloitte Touche Tohmatsu and the National Venture Capital Association (NVCA), released in June 2009, revealed that 63 percent of VCs were planning to increase their investments in cleantech over the next three years. Investments in cleantech, including biofuels, started declining through 2008, though it still was a better year than 2007. Analysts are predicting that due to the declines in 2009 investments seen by mid-year, VC investment in alternative energy is not likely to catch up to the previous year's numbers.

According to Rory O'Driscoll, managing director, Scale Venture Partners, venture capital will be one of the best places to put money over the next few years, despite the short-term dislocations. "The key is to absorb the mark to market quickly, and invest today based on where 2010 will be, not where 2007 was. IT, life science and cleantech companies can be purchased at all time lows. Unlike 2001, these are companies with viable and efficient business models that are cheap — not because they are broken but because the world is. Once the world heals, they will bounce back strongly," O'Driscoll said.

Cleantech Investment Starts Decline in 2008, Rebound in 2009

The first quarter of 2009 represented the lowest point in VC investment in cleantech since the fourth quarter of 2005. Yet, PricewaterhouseCoopers (PWC) and the NVCA still call cleantech the fastest-growing VC investment sector. In fact, Cleantech Group LLC reported in July 2009 that preliminary results for the second quarter of 2009 showed that cleantech venture investments had started to rebound.

"Cleantech venture investment has rebounded moderately after free-falling for two consecutive quarters," said Brian Fan, senior director of research, Cleantech Group, in a release. "We are seeing initial signs of recovery in other cleantech asset classes, including recent activity in solar tax equity, increased M&A levels, as well as billions in government stimulus that are being allocated globally to the cleantech sector over the next several quarters. Additionally, new climate and energy legislation from governments worldwide and the upcoming Copenhagen climate negotiations continue to be strong drivers of investment and innovation."

In the first quarter of 2009, VC investments in cleantech — comprising alternative energy, conservation, power supplies, pollution and recycling — dropped 84 percent, to \$154 million in 33 deals. In the fourth quarter of 2008, 67 cleantech deals brought in \$971 million, according to *The MoneyTree Report* from PWC and the NVCA. Earlier that year, the first quarter of 2008 had brought in \$1.24 billion in cleantech investments.

According to the report, the cleantech sector saw a 15 percent increase in the second quarter of

Interest Is Accelerating in Algae Biofuels

First, there was ethanol. Then there was cellulosic ethanol. Now, there is algae.

Though not yet widely produced on a commercial scale, a number of companies are planning the move from research to commercial production of biofuels from algae. Part of this is due to corn-based ethanol being unviable in terms of cost and corn production, and cellulosic ethanol being a few years away from being a cost-effective alternative as well. More than 200 companies already have jumped into the algal-biofuels arena, with investments and research coming from Big Oil companies such as Royal Dutch Shell plc, BP plc and Chevron Corp., and airlines like Virgin Airlines, Boeing, Japan Airlines and New Zealand Airlines.

Fuel from algae often is called a third-generation biofuel, coming after first-generation ethanol and next-generation cellulosic ethanol. Because of its potential for high oil yields, many people in the renewable fuels industry have abandoned their earlier pursuits of biofuels and are placing all hopes in these microorganisms. Algae are rich in oil, can grow on marginal land and water, and also have environmental advantages as they absorb carbon dioxide (CO₂), nitrates and phosphates while releasing oxygen. They have a high energy content, are fast-growing, and have a high energy yield per acre.

The yield of algae is significantly higher than that of any traditional crop. The U.S. Department of Energy (DOE) estimates that algae may have the capacity to produce 100 times more oil per acre than soybeans used for biodiesel. In contrast to feedstocks that can be made only into ethanol (corn, cellulose) or biodiesel (jatropha, soybeans), algae can be used to make ethanol, biodiesel, “green” gasoline, biobutanol, biomethanol and jet fuel. The actual fuel yield of algae is 819 gallons per acre, and that number could increase as more developments are made. Chinese tallow comes in at 699 gallons per acre, but popular feedstocks do not come close to such a high yield. Future predictions for algae yields are as high as 20,000 gallons per acre.

“There’s a lot of energy out there,” said Lawrence Berkeley National Lab’s Nigel Quinn in an article about his one-year algae project on the Energy Biosciences Institute website. “It’s very easy to grow — all you need is sunlight and water. But with fuel from algae, it’s all about the economics. In order to cultivate and convert algae to oil, you need huge systems.”

The biggest challenges for algal-based fuels are growing enough to meet ever-increasing energy needs, as well as determining a cost-effective algae-to-fuel process. While bioreactors are most effective for quickly producing high-quality algae, they also are more expensive than other methods, since they usually require computer control and monitoring, and can present problems related to temperature control and water storage on land. Currently, the majority of commercial-scale algae in the U.S. are grown in open ponds, shallow containers that use paddle wheels to circulate the water. This method is prone to evaporation, contamination and a lower energy yield. Due to evaporation, open ponds must have a steady supply of water.

The applications for algae are more diverse than most feedstocks as well: In addition to their potential use in a variety of renewable fuels, algae also remove carbon dioxide (CO₂) from the air while growing. Most research efforts center on microalgae rather than macroalgae (giant algae

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