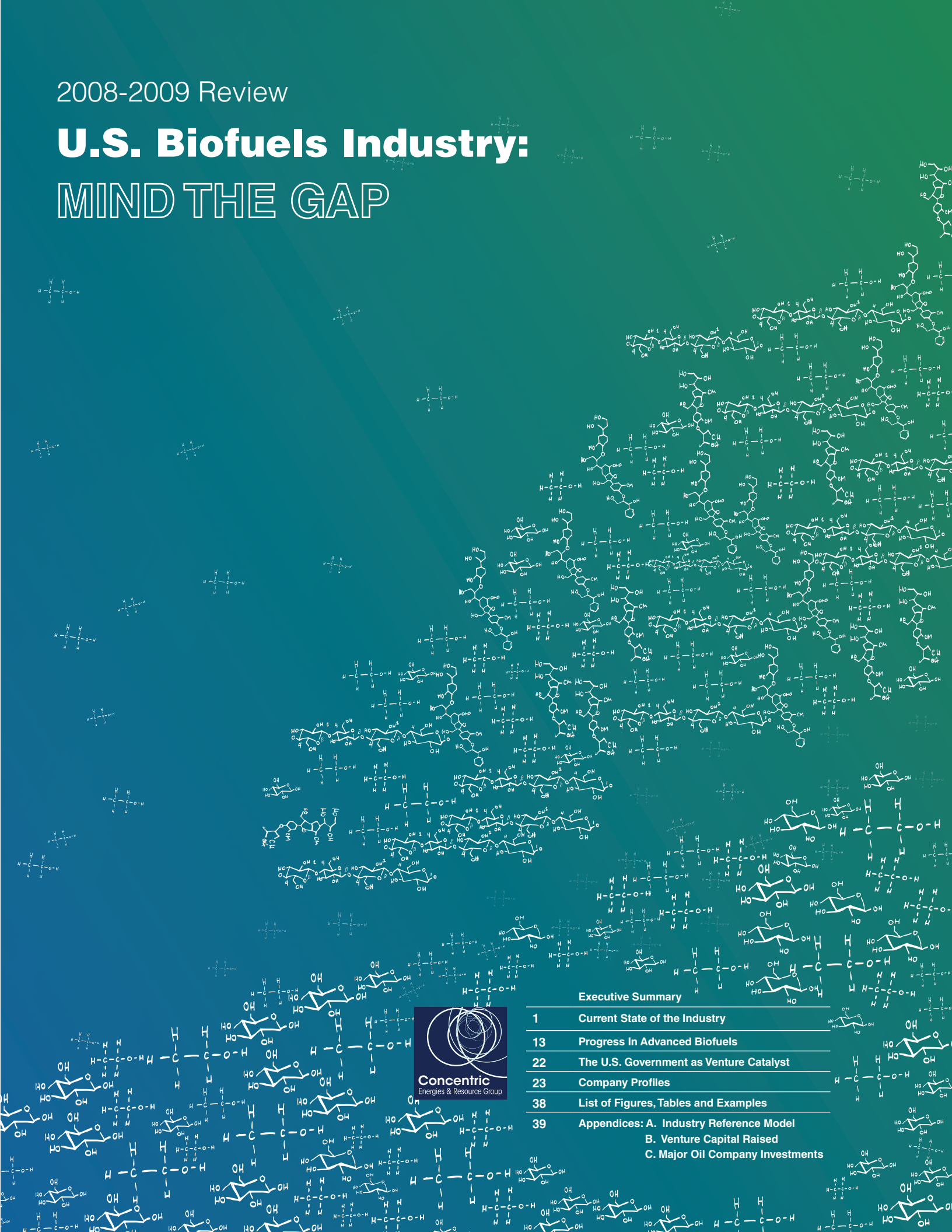
2008-2009 Review

U.S. Biofuels Industry:

MIND THE GAP



Concentric
Energies & Resource Group

ABOUT THIS REPORT

This report was prepared by Brian Curtis of Concentric Energies & Resource Group, Inc. as an independent consultant to the U.S. Department of Energy. It is intended to provide an objective view of the evolving biofuels industry and many of its key participants. It is the second "Year in Review" report created for use by an intended audience of industry, investor, policy maker and regulator stakeholders. This report covers the 2-year period of 2008-2009.

FUNDED BY THE OFFICE OF THE BIOMASS PROGRAM

The Office of Energy Efficiency and Renewable Energy's Biomass Program works with industry, academia and national laboratory partners on a balanced approach to advance biomass as a significant and sustainable energy source for the 21st century. Through research, development and demonstration efforts geared towards establishing the integrated biorefinery model, the Biomass Program is helping transform the nation's renewable and abundant biomass resources into cost competitive high performance biofuels, bioproducts and biopower.

The Biomass Program supports four key priorities of the EERE Strategic Plan:

- Dramatically reduce dependence on foreign oil
- Promote the use of diverse, domestic and sustainable energy resources
- Reduce carbon emissions from energy production and consumption
- Establish a domestic bioindustry

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EXECUTIVE SUMMARY

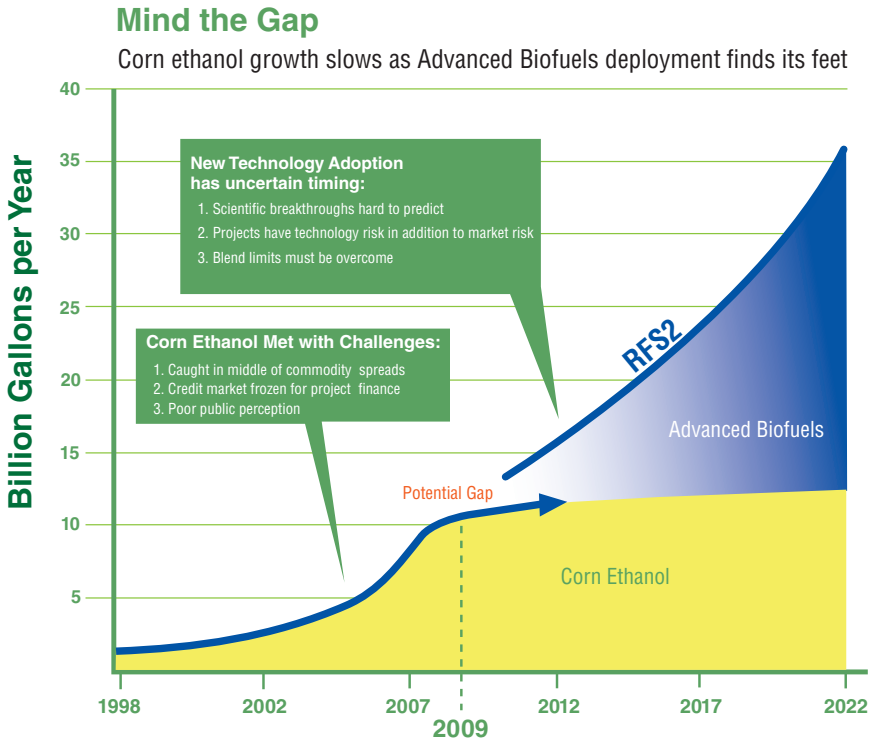
2008 and 2009 were difficult years for the U.S. biofuels industry. Following a 5-year growth spurt that saw more than 25% average production increases year over year, the industry was forced to manage growing pains in the midst of a global recession, volatile commodity markets and a lack of project financing. The result was bankruptcies and delays in new construction starts. At the same time, commercial deployments of advanced fuels progressed more slowly than predicted. Misperceptions surrounding energy balance, carbon footprint and food vs. fuel have also continued to plague the industry. Consequently, biofuels have gained a negative reputation in some sectors of the U.S. public eye.

Despite turbulent times, national production kept up with the Renewable Fuel Standard (RFS) set forth in the 2007 Energy Independence and Security Act (EISA) that requires a significant yearly increase in biofuels production. Furthermore, commercialization progress was made by innovative start-ups. The risk for the industry lies in the possible gap between the existing corn ethanol industry foundation and the emerging advanced biofuels industry. If deployment of advanced fuels is delayed, public sentiment may drive legislators to back off on the RFS. This would be a major setback for the industry, possibly stifling it before it has a chance to reach technical and commercial maturity.

BANKRUPTCIES CLEAN HOUSE

The majority of the bankruptcies in the industry occurred in late 2008 and early 2009. In February of 2009, roughly 91% of ethanol companies were still financially healthy and weathering the recession. However, by July 2009, 23 plants were operating at a reduced capacity factor. Notably, VeraSun – previously the third largest ethanol producer in the U.S. – filed for bankruptcy in November 2008 and subsequently sold many

Figure 0.1



of its assets to oil major Valero. The causes of these bankruptcies are many but some common themes are worth discussing, including:

- Commodity swings (corn up, ethanol down)
- Corn price hedging and inexperience
- Timing and volatility of demand
- Limited pricing incentive to blend above the RFS level

The second half of 2008 saw corn prices up and fuel prices down. The resulting economics led the industry to idle the plants with the highest marginal costs to produce. The industry reference model developed for this report shows theoretical losses of more than $0.70/gal for first half of 2009. There are several components to cost structure that should be considered including: technology; capital structure and debt load; construction cost over-runs; and poor commodity price risk management. The industry has benefited from a favorable alignment of corn and oil prices in the second half of 2009 that has enabled many companies to begin to climb out of the losses of the previous year and a half. Industry averages suggest that typical ethanol mills experienced $0.36/gal profits in December 2009. This is still short of the $2.00 per gallon margins of mid-2006, but significantly better than the $0.20 to $0.30 losses some producers were experiencing in May 2009 (Iowa State Extension data).

Biodiesel makers, on the other hand, while showing some improvement from peak losses of $0.22 per gallon in July 2009, are struggling to break even as a revival of the $1.00 per gallon tax subsidy remains stalled in Congress.

RFA data shows total production capacity of over 13.0 bgpy and 2009 production of 10.75 billion gallons, compared to 10.5 billion gallons required in 2009 by the RFS. Despite excess capacity, new plants were still being added toward the end of 2009.

All told, this may be a healthy correction as high cost structure producers are restructured or decommissioned. These trends have led to contraction and consolidation in the industry. An example of this is the previously mentioned asset purchase of a large portion of VeraSun by Valero.

However, the industry remains fairly fragmented with the largest five producers making up only 33% of current capacity. The remaining 67% is spread across 125 companies.

Financial Market Crippling

Industry-specific dynamics aside, the impact of the global banking crisis on ethanol producers was not trivial. Under normal circumstances, tough commodity swings and demand uncertainty are difficult, but manageable. When the overall stock market is down by more than 50%, however, stock prices and balance sheets are hit hard. Lack of credit availability blocked companies from financing working capital and new projects.

CAUTIOUS RECOVERY

There are some bright spots to be found. In the face of recession and banking worries, the industry nonetheless received record levels of funding from government and private equity investors. Companies are also pushing hard to advance production and product technologies in an economically feasible and environmentally sustainable way. Towards the end of the period, a large number of idle plants came back online due to more favorable pricing circumstances and/or streamlined capital structures. As of January 2010, the number of plants operating below capacity was down to 18 (1.2 bgpy of unused capacity). This is an indication that the industry is on the road to recovery.

Growth Capital Is Flowing

While project finance for corn ethanol production has been weak, there have been record levels of capital flowing towards biofuels. In February 2009, the industry received nearly $800 million from the American Recovery and Reinvestment Act to be administered by the DOE, indicating Congressional support remains. An additional $1.46 billion worldwide has flowed in from venture capital funds since the beginning of 2008. The oil industry is also making its presence felt with nearly $2 billion in known commitments and at least 20 major deals of undisclosed amounts initiated since 2005. See Appendices B and C for more detail and sources.

Table 0.1

2007 Renewable Fuel Standard

[billion gallons per year]

			2007 RFS		
	Total RFS, All Fuels	Actual Corn Ethanol	Corn Ethanol	Other Advanced Biofuels	Cellulosic Biofuels
1998		1.40			
1999		1.47			
2000		1.63			
2001		1.77			
2002		2.13			
2003		2.80			
2004		3.40			
2005		3.90			
2006	4.00	4.86			
2007	4.70	6.45			
2008	9.00	9.00	9.0		
2009	11.10	10.75	10.5	0.6	
2010	12.95		12.0	0.85	0.10
2011	13.95		12.6	1.1	0.25
2012	15.20		13.2	1.5	0.50
2013	16.55		13.8	1.75	1.00
2014	18.15		14.4	2.0	1.75
2015	20.50		15.0	2.5	3.00
2016	22.25		15.0	3.0	4.25
2017	24.0		15.0	3.5	5.5
2018	26.0		15.0	4.0	7.0
2019	28.0		15.0	4.5	8.5
2020	30.0		15.0	4.5	10.5
2021	33.0		15.0	4.5	13.5
2022	36.0		15.0	5.0	16.0

Blending Schemes Being Explored

The amount of ethanol that can be blended into the general gasoline supply is currently being discussed to increase beyond the currently allowed 10 percent (E10) and 85 percent (E85) for use with flexfuel vehicles. A preliminary report published by NREL in October 2008 (and a subsequent revision in February 2009) reported no unexpected test results for intermediate blends of E15 and E20. Additional studies are still on going on small engines and older vehicles.

Beyond intermediate blends, many are advocating wider adoption of E85 infrastructure as well as development of products that are more readily integrated into existing infrastructure as described in the Advanced Fuels sections of this report.

Advanced Fuels Being Monitored

After much attention in 2007, cellulosic ethanol has given up some of the limelight in 2008-2009 to alternative bio-based fuels. A handful of pilot and demonstration projects have come online over the period and appear to be netting favorable results. The goal is to create products that use existing infrastructure. This can come in the form of fuels that feed into refineries or downstream into existing pipelines. Algae has also received a lot of attention from investors with more than $800 million in funding, including a noteworthy $600 million commitment by Exxon Mobil to a partnership with Synthetic Genomics. However, like cellulosic ethanol in 2007, these advancements still need to prove themselves before commercial deployment. Furthermore, some companies are waiting in the wings to assess the viability of commercial applications of these technologies.

Rising Awareness of Carbon Dioxide Emissions

Carbon dioxide emissions have always been a factor in biofuels industry development and legislation. But the focus has been renewed as climate change and energy legislation are considered in Congress. The Obama administration has identified carbon emissions as an important topic, although no legislation has been passed.

The important point to keep in mind is that not all biofuels are created equal. Technology, feedstock source, power supply and plant configurations have a significant impact on emissions. Cellulosic ethanol and renewable diesel can provide significant reductions in carbon footprint relative to the fuels they replace. Early commercial-scale technologies such as corn ethanol and biodiesel continue to improve and serve as good first steps towards a more sustainable energy future. These factors are playing heavily into current technology development and investment trends.

Regulatory Systems Are Evolving

New carbon legislation is being discussed in Congress. The EPA is taking a lead role in the design of a system to implement the RFS. In 2009, they released a draft set of regulations for comment which were incorporated before releasing the finalized rule in February 2010.

The finalized "RFS2" contains specific changes from the earlier Renewable Fuel Standard. It includes non-road gasoline and diesel fuel volumes and establishes and defines four distinct categories of renewable fuels, which are:

1. Advanced biofuels
2. Biomass-based diesel
3. Cellulosic biofuels
4. Total renewable fuel (including corn-based ethanol)

A CRITICAL TIME

Certainly, there is no single solution for energy security and independence, but biofuels remain a significant storyline as the U.S. works toward a new energy future. Energy efficiency programs, other renewables development such as wind and solar and solutions for existing fossil energy (including domestic coal) will advance in parallel. Biofuels of all forms–corn, cellulosic, advanced, biodiesel–are well positioned to positively impact the U.S. energy mix. In order to meet national objectives including promotion of sustainability and green jobs, this next phase must be carefully navigated by: 1) staying steady but flexible with biofuels legislation and regulation; and, 2) supporting an industry environment that breeds innovation.

CURRENT STATE OF THE INDUSTRY

CORN ETHANOL INDUSTRY GROWING PAINS

In the face of a tough economic downturn, it's easy to forget that the biofuels industry is still in high growth mode. Dominated primarily by corn ethanol, the industry production volume has grown 15%, 24%, 34%, 38% and 19% each respective year from 2004 to 2009 (RFA). Capacity has grown even faster. In short, the industry has almost tripled in size since 2005. While growth in 2008 and 2009 have slowed, this is consistent with the "S-curve" industry trajectory predicted by the RFS, which shows corn ethanol leveling out at 15 bgpy in 2015. Consider the industry in this context. With recent high corporate failure rates and weak operating margins, the question becomes whether the current state of affairs is a function more of 1) growing pains, 2) fundamental flaws in the industry or 3) the global recession. The next question is whether each of these is correctable, and, if so, in what time frame?

This chapter addresses aspects of each, ranging in topic from cost/pricing dynamics to environmental sustainability to infrastructure to financial markets. However, it is also important to note that both the growing pains and the underlying fundamentals are critically tied to technology and innovation as described in the next chapter. In this sense, looking at conventional corn ethanol as a stand-alone biofuels solution would be only a partial analysis.

Also addressed in this chapter are similar dynamics that exist for biodiesel.

Ethanol Plant Utilization and Industry Growth

The US ethanol industry is currently in a dynamic state with 201 ethanol production facilites with capacity estimated at 13.0 bgpy, of which 2 bgpy was idle at one point or another in 2008-2009 (RFA). Included in that capacity are 62 new plants, concentrated mostly in the Midwest, which added 5.1 bgpy of new capacity in 2008 and 2009. Unfortunately, 750 mgpy of the new capacity was idled within a year, accounting for approximately half of the idle plants by end of

Figure1.1

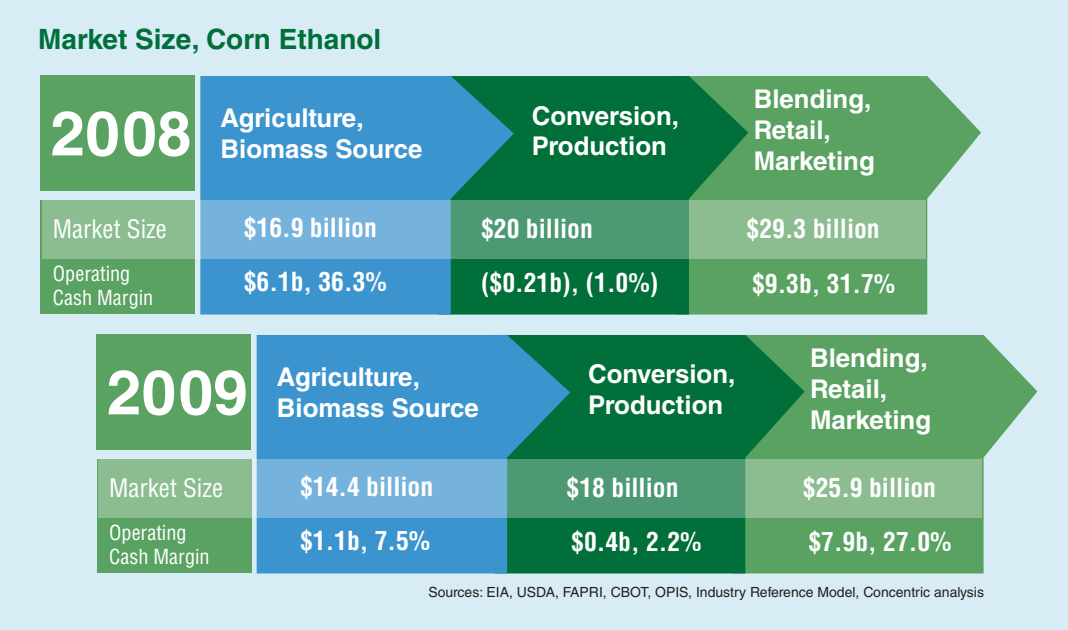
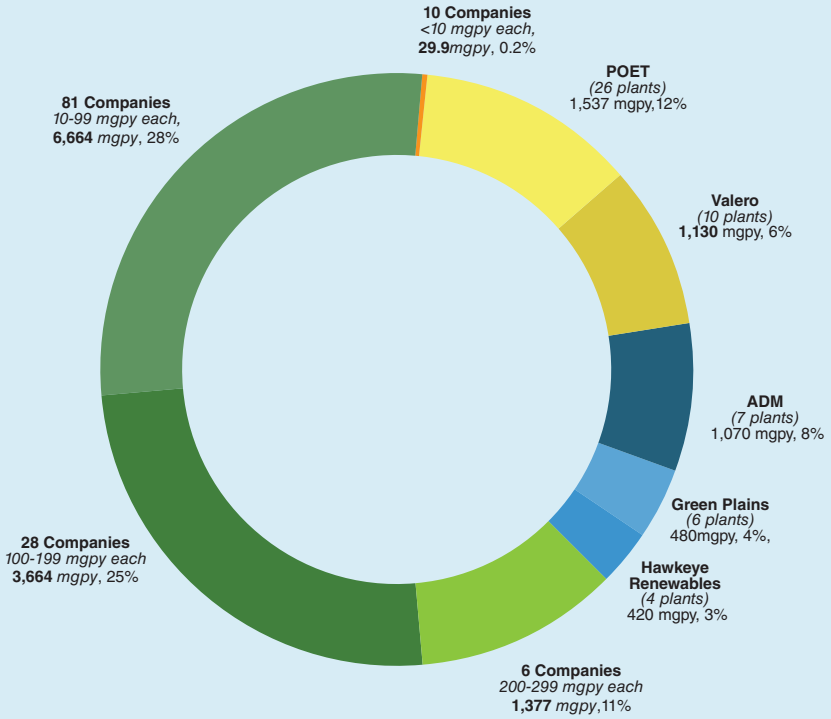
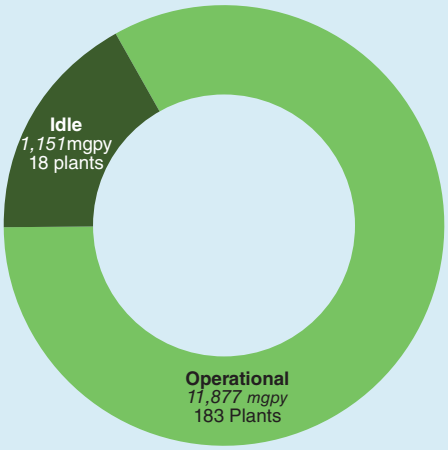


Figure1.2

U.S. Ethanol Capacity by Company, December 2009



Plant Utilization, December 2009



Source: RFA

summer 2009 when the industry situation was most dire. At least 13 different companies had new capacity under construction in January of 2010, totalling 1.4 bgpy. Despite the cognitive dissonance of bankruptcies, idle plants and new builds happening concurrently, this is not necessarily a conflict in terms.Reasons for the idle plants can be summarized in three main points:

1. Capital structure of many plants left high debt burden in a poor economy
2. First generation plants are less efficient and have a worse cost structure
3. New plants came online and were hit by the economic downturn before being able to find their footing in the market.

Conversely, growth drivers continue, including:

1. Regional supply and distribution dynamics
2. New technologies are ofter able to compete on pricing at the margin.
3. Government mandates and incentives.

Is this low level of plant utilization across the industry an emerging industry operating pattern? Is annual capacity factor something to calculate into project financing? It is not clear how the industry will stabilize over time, but one thing is clear. Commodity pricing is the single largest driver in ethanol plant economic viability. Effective management of it will make or break many companies going forward.

Ethanol Pricing Factors

The relationship between the prices of ethanol, oil and corn is a topic that continues to be hotly debated. Both transportation fuels and corn prices spiked sharply in 2008 but peaks and drops were out of sync. The corn price spike lagged behind the gasoline and ethanol price spikes by about 6 months, leaving ethanol producers caught in the middle of these commodity price swings. Further, since the RFS ensures a market for biofuels, corn ethanol was often blamed for much of the volatility in the food market in 2008. However, it seems the most important causal relationships are the independent effects of oil price on both ethanol and corn prices, respectively, as well as the impact of corn prices on ethanol costs, which affect production volume and price.

It is a complex picture with multiple pricing mechanisms at play at any one time.

Ethanol and gasoline price relationship

To best understand the ethanol-gasoline price relationship, consider the historical price spread as shown in Figure 1.7. Notice that the prices are highly correlated but ethanol's price swings are more extreme. There are multiple factors that drive this pricing relationship and drive demand for use of ethanol in a gasoline blend.

Ethanol price is correlated to gasoline price in a complex fashion. There are at least 5 reasons to blend ethanol into gasoline depending on region, seasonality and end user demands:

Regulatory factors:

1. RFS requirements
2. Oxygenate requirements
3. Octane requirements

Pricing and market factors:

4. Volumetric replacement
5. Energy content replacement

When considering gasoline, oil and corn prices, price should not be confused with cost. As explained below, the pricing relationships can be complicated. For example, the price of oil affects both the cost and the price of ethanol. Ultimately, the important metric is the operating margin of the ethanol producer.

Oil affects ethanol

Oil plays an important role in ethanol pricing in two important ways. First, oil costs to farmers are passed on to ethanol producers in the form of corn prices, having a direct correlation on ethanol prices but potentially an inverse effect on ethanol supply, if production costs become prohibitive. The price of natural gas has a similar effect, as natural gas-derived fertilizer accounts for 36% of the costs of corn farmers.

Secondly, ethanol blending limits tie demand for ethanol to demand for oil. While high oil prices contributed to top line growth for ethanol in late 2007 through mid- 2008, oil prices dropped rapidly at the end of 2008 and the beginning of 2009. Largely a function of the economic downturn and

difficult global circumstances, the drop in oil prices was accompanied by a drop in volume. This had an adverse effect of ethanol economics and utilization.

Ethanol affects gasoline and oil

Recent studies indicate that ethanol blending in the U.S. has led to lower retail gasoline prices, from 7 cents per gallon to 50 cents per gallon (Sources: LEGC, Iowa State University, RFA and Merrill Lynch). While an increase in the RFS blending limit would likely further reduce gasoline prices, this would also require significant investment in fuel transportation infrastructure. Ethanol's affect on crude oil is less pronounced because crude oil prices are more affected by diesel demand and OPEC supply decisions than by the gasoline market.

Corn Affects Ethanol

The failure of a number of ethanol producers to deal with corn price volatility over the last two years indicates that there is an important relationship between the price of corn and ethanol cost and production levels. As corn makes up as much at 70% of ethanol producers' costs, corn price increases made it increasingly more expensive for ethanol processors to make ethanol from corn. The lower price of corn has resulted in a more economically viable ethanol industry in 2009

Ethanol Affects Corn

Currently, the ethanol industry accounts for approximately one third of corn demand for production of ethanol for fuel and DDG for animal feed. Most experts agree that while demand from the ethanol industry contributed to rising corn and food prices beginning in 2007, other market factors including oil prices (especially with a weaker dollar), export demand and weather likely had more significant effects. The corn price spike in 2008 was largely due to a combination of high oil prices and demand from other sectors together with the increased demand from ethanol producers due to a number of new facilities that came online.

The correlation of corn and ethanol prices since the beginning of 2007 has led many to hope that ethanol demand has brought about greater price

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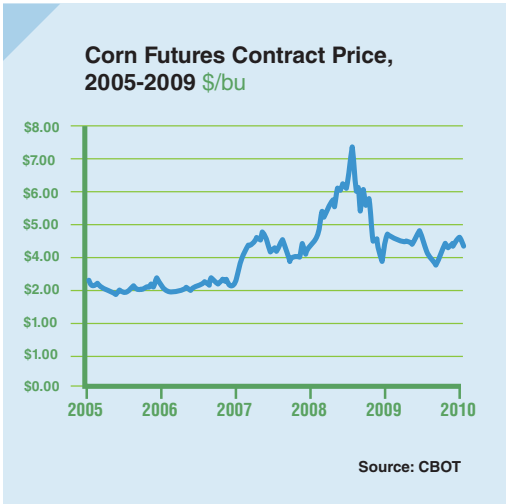

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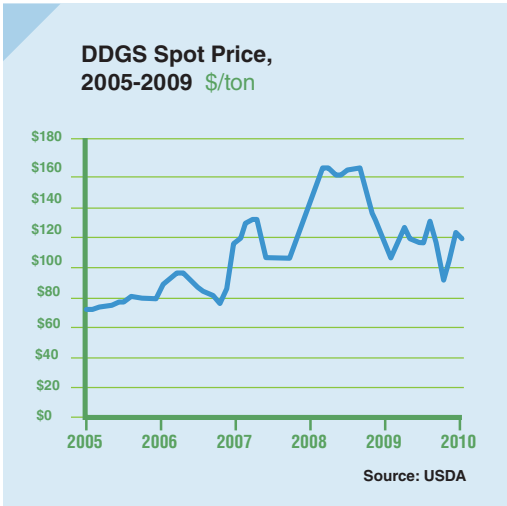
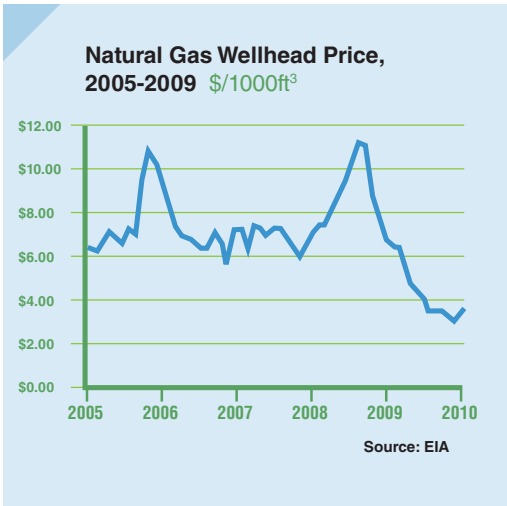


Figure1.5



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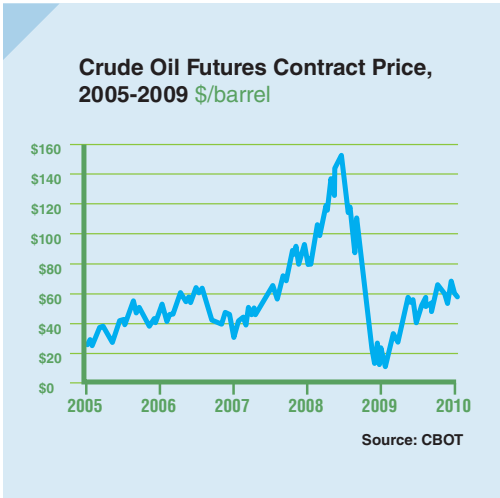
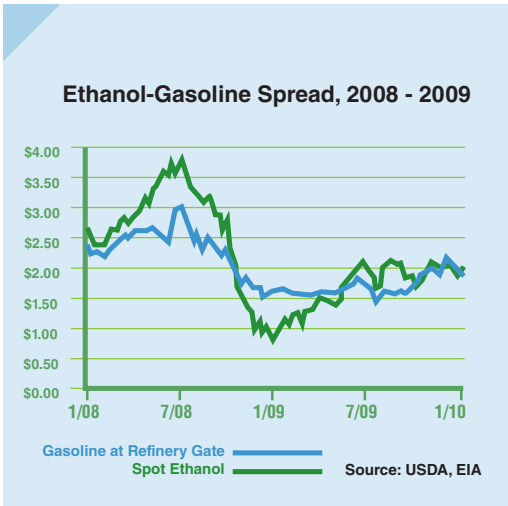


Figure 1.7



stability in the corn market. One explanation for the recent stability is that the ethanol industry is the marginal consumer in a short corn market, able to adjust and ration demand to match supply by idling facilities. The argument suggests that demand for corn in the ethanol industry is more elastic than demand from food and livestock feed, the price of corn may effectively be pegged to the price of ethanol. If the price of ethanol rises, ethanol producers will be more willing to buy corn at a higher price, and corn prices will follow.

While this argument may have some validity, the ethanol blending limits and actual costs of idling production reduce the industry's elasticity. As long as corn use in ethanol production increases, corn prices (as opposed to corn cost) will continue to be strongly influenced by oil prices. While the above mentioned effect could add some stability to corn markets, the increasingly intertwined relationships between oil and agricultural markets do not indicate that corn prices will be wholly predictable. Similar to ethanol, corn will continue to have multiple competing price drivers.

Public Policy Affects Ethanol

While the RFS has undoubtedly increased the demand for ethanol, its effects are currently limited by the blending wall that restricts how much ethanol the market can absorb during periods with favorable pricing dynamics. Since the RFS was adopted in 2006, ethanol production has exceeded the mandated annual level.

This may change if federal blending limits are increased. Critics in the livestock and food industry have indicated that an increase in the ethanol blending limit would lead to almost half of the corn crop being used for biofuels by 2015--- a level at which ethanol's impact on corn prices would be undeniable. High ethanol production does induce a higher corn price, but, at high oil prices, the role of oil prices in corn price dynamics is more important than policy.

GETTING PRODUCT TO MARKET

Ethanol product logistics and blending dynamics continue to be important pieces of the transportation fuels infrastructure puzzle. To date, product has primarily been delivered to blending terminals via truck and rail. However, 2008 began to show signs of activity in the pipeline sector, which may help drive costs out of the system and allow for greater market penetration.

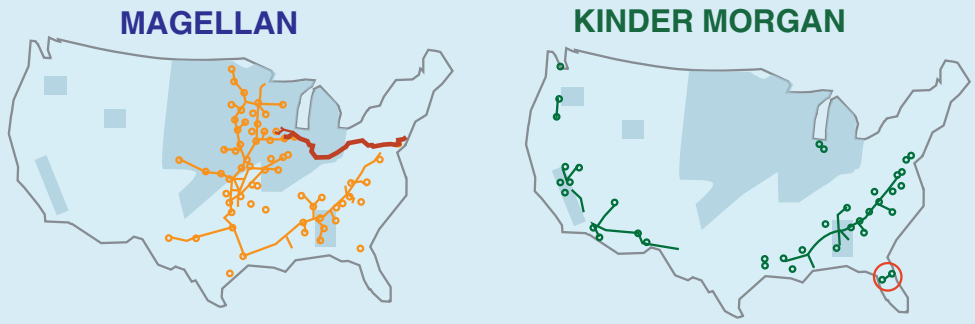
As mentioned previously, another driver of market penetration, in the medium term, is the blend rate of ethanol into gasoline. The major indicators to watch are E85 station roll-out and the EPA's pending discussion on intermediate blends; the latter has made significant progress in 2008-2009.

Pipelining Ethanol

The main challenges for shipping ethanol by pipeline are corrosion and affinity for water absorption, both of which have generally precluded the use of existing liquid fuel pipelines. Until recently, conventional wisdom was that dedicated pipelines were required. However, in December 2008,

Figure 1.8

Ethanol Pipeline Projects



Kinder Morgan began shipping ethanol in the southern branch of their Plantation Pipeline. The project entails a 105-mile stretch of pipeline in Florida. At a reported upgrade cost of approximately $10 million, this demonstration is a leading positive indicator of the possibilities.

In terms of dedicated pipelines, the vision has been to connect the corn belt in the Midwest to the Northeast markets via a dedicated pipeline. To this end, in March 2009, POET and Magellan Midstream Partners kicked off a feasibility study for just such a project. Preliminary estimates suggest that a project of this sort would cost in the $3.5 billion range. Technical feasibility is one aspect to consider; how to finance a large-scale dedicated pipeline is another. There are 3 financing factors to take into account for this nascent segment of the industry:

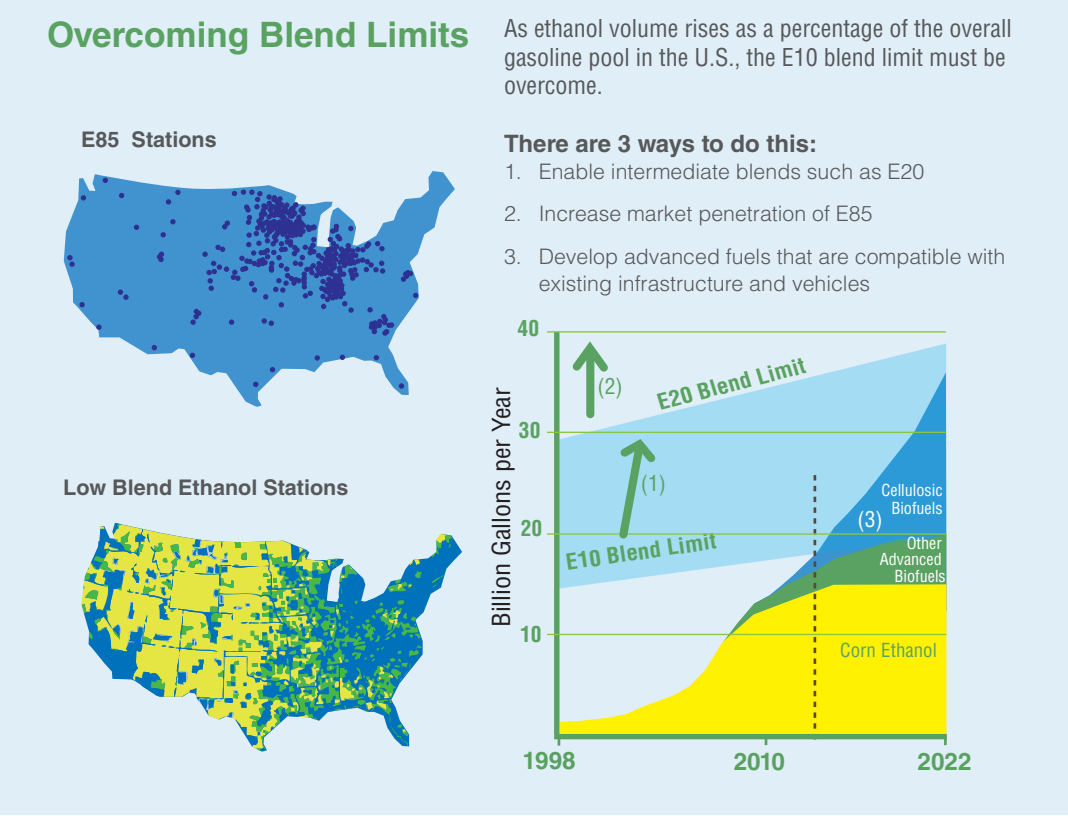
1. Business model. In contrast to the business model for ethanol producers which is subject to commodity price swings, the pipeline model is generally a "toll" model whereby the operator is paid a fee for volume shipped regardless of the price of the underlying product. This bodes well for the finance capabilities of projects (assuming the technical risks are adequately addressed).
2. Availability of project capital. This is largely a function of greater economic conditions as discussed in later sections of the report.
3. Loan guarantees. The federal government has the potential to provide loan guarantees for these projects which would help kick start the segment. This approach has been supported by many ethanol state members of Congress, but may require a legislative change.

Beyond the introduction of pipelines for ethanol, some advanced biofuels technologies are making a push to solve the issue by producing fungible fuels (aka "renewable gasoline" and "renewable diesel") that are more closely related to traditional fuels and can be pipelined with no additional upgrades. This economic benefit will be a competitive advantage for such fuels, especially in markets that are not served by major pipelines where an economic case can be made to upgrade for ethanol.

Intermediate Blends Are Key Indicator

The amount of ethanol that can be blended into the general gasoline pool is limited to

Figure 1.9



approximately 10 percent of the total volume. This remains the limit due in part to concerns about the effects higher ethanol blends may have on internal combustion engines, particularly as voiced by auto makers and insurance companies, but in practice is controlled by the Environmental Protection Agency (EPA) on the basis of the Clean Air Act. A science and consensus-based approach is helping ensure that key constituents can participate in the rule making.

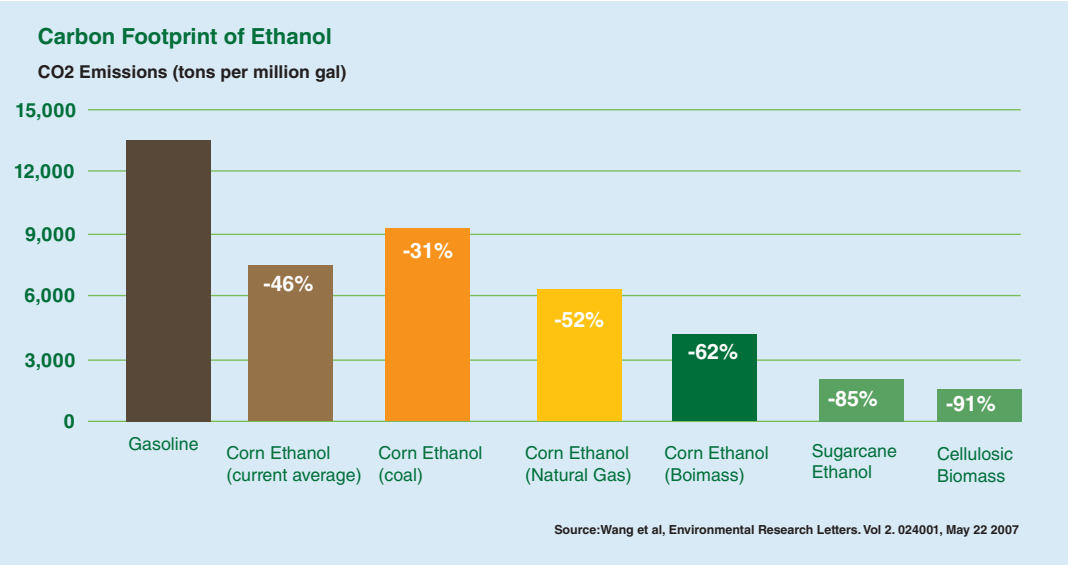
At current levels of fuel demand, this 10% "blend limit" amounts to about 10-14 bgpy. Thus, the question arises of how the industry will be able to move beyond this level to comply with the RFS as it ratchets up every year towards the 36 bgpy target in 2022.

GREENHOUSE GAS EMISSIONS AND ENERGY BALANCE

Greenhouse gas emissions gained much awareness for the biofuels industry in 2008 and 2009 as new energy legislation was debated in Congress.The major theme that has carried through the discourse is that not all biofuels are created equal. Depending on the biomass source, land management practices, processing technology, production facilities' source of power, and the infrastructure used to reach market, various biofuels can have significantly different carbon footprints.

At the forefront of deliberation regarding the complexities of carbon accounting within the industry during the public comment period from May to September 2009 was the EPA's proposed RFS2 rule and its included emissions standards. The EPA's RFS2 rule proposed in May of 2009 and finalized in February 2010 includes for the first time indirect land use change in accounting for the carbon footprint of biofuels. While this reduces the perceived reduction in greenhouse gases attributable to corn ethanol, the EPA's models as well as many other recent studies

Figure 1.10



have, in fact, found that biofuels reduce greenhouse gas emissions relative to gasoline and petroleum-based diesel.

FINANCIAL HEALTH OF THE INDUSTRY

Revenue and Profit Distribution

Due to high commodity prices, revenues rose and industry averages showed significant growth. However, this does not tell the whole story. In 2008, a year of volatile corn and oil prices, the story is really one of profit distribution across the supply chain. During this period, the ethanol industry was often caught between a rock and hard place with corn prices swinging up and oil prices swinging down. As a result, corn farmers and oil companies had strong financial years while the ethanol industry had largely negative returns.

As was the case in last year's report, an Industry Reference Model is used to estimate overall industry performance and is based on average industry prices for gasoline and spot prices for ethanol over each period. Each segment of the supply chain is considered with industry average margins for that particular sector. As shown in Figure Figure 1.11 ("Total Industry Revenue"), top line growth was significant in 2008. But, as mentioned above, the margins continued their drop from the 2006 peak.

Stock Performance and Bankruptcies

Pure play biofuel stocks started the period in weak condition and were only further hurt by the global recession. Additionally, despite some pockets of strength in pricing for key commodity inputs and outputs, large agricultural (eg, MON, ADM) and energy (eg, CVX, BP) companies were also hit hard.

As has been discussed at length already in this report, the result has largely been a spate of bankruptcies and a redistribution of assets in the industry. From a stock investor's point of view, the question becomes which companies will survive the downturn for the swing back up and which will reach the point of no return at a moment when they can be acquired for a fraction of the asset value. There are some fundamental corporate metrics and strategies to consider, including the strength of the balance sheet and the level of vertical integration. This environment will generally favor large resource- oriented companies such as the Oil Majors. As a result, it is no surprise that their stocks did not fall nearly as far and, in fact, kept in line with the major indexes. A notable exception here is Valero which was likely dragged down in part due to their ethanol and downstream fuels exposure.

Despite slim margins in the biofuels industry, more financially stable Oil Majors did take advantage of the market's downturn through ethanol asset

Figure1.11

Total Industry Revenues, 2005-2012

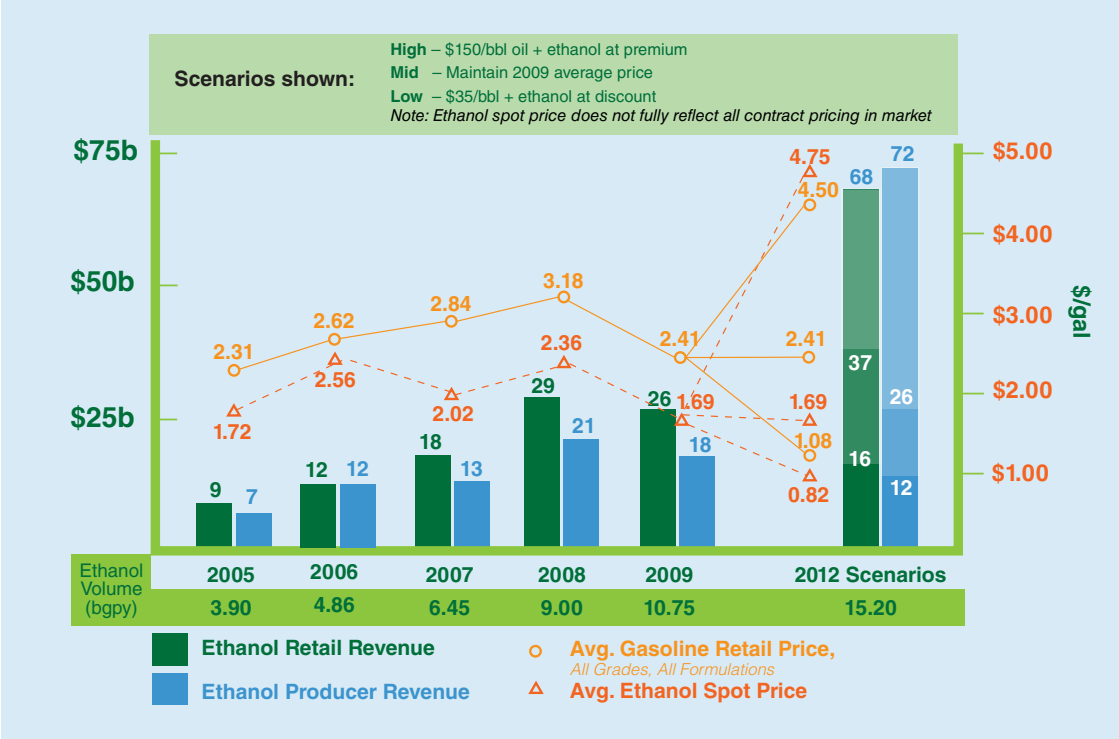
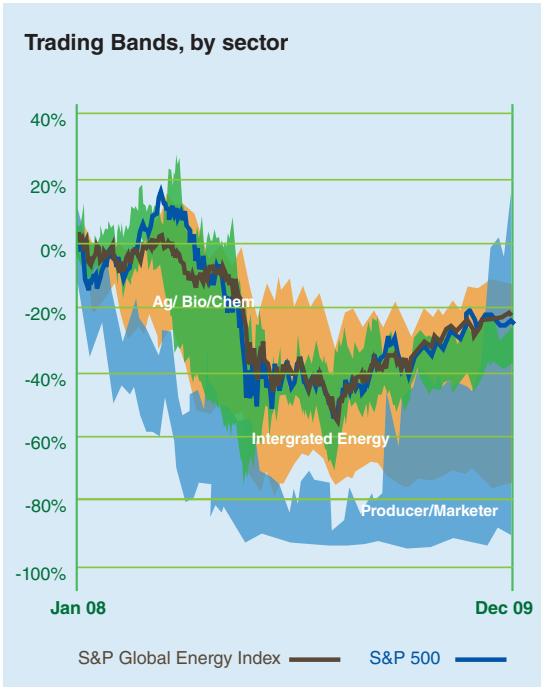


Figure 1.12

Relative Stock Performance, 2008-2009



purchases as well as investments in earlier stage technologies. Down the road as the economy recovers, the stock market landscape for biofuels may look vastly different than it did going into the down turn. Ethanol pure plays may be difficult to find. Having said that, it will be interesting to track the progress of venture-backed advanced fuel companies when the IPO window begins to open. See also further discussion in Investment Trends section of Chapter 2.

BIODIESEL

The biodiesel industry, still made up predominantly of small plants relying on local supplies of feedstock oil, was hard hit in 2008 and 2009. High food oil prices, falling diesel prices, and public policy concerns about its long term efficacy left the industry operating at just 15% capacity, with most of the 140 National Biodiesel Board member plants producing at levels far below their total capacity of 2.7 billion gallons per year at the end of 2009 (NBB). This contrasts with an albeit shaky recovery in the ethanol industry, which now has 11.8 billion, or about 91%, of its 13.0 billion gallon capacity in operation according to the Renewable Fuels Association as of January 2010.

Similar to the ethanol sector, most of the biodiesel industry's difficulties reflect the hazards of a business that depends on two volatile, unrelated commodities: vegetable oil and petroleum. The industry survived 2007 increases in food oil prices thanks to a rise in petrodiesel prices to over $4.75 per gallon that allowed biodiesel to remain price competitive. However, the fall in crude oil prices and lower energy demand due to the global recession have erased biodiesel's price competitiveness and profit margins.

Slumping margins have affected producers worldwide. In the spring of 2009 the European Commission voted to extend anti-dumping tariffs against cheaper U.S. bodiesel imports in order to insulate its struggling domestic biodiesel industry from U.S. subsidies. In November of 2009, the European biofuel industry expressed its dissatisfaction with what it sees as continued evasion of its anti-dumping duties by American producers. The new policy has already delivered another blow to the U.S. biodiesel industry and seems to have stimulated a slight recovery for European producers, though European Biodiesel Board statistics indicate that the European industry is still operating at approximately 50% of capacity, which increased from 16 million tonnes to 20.9 million tonnes in 2009. (2009 EBB production statistics have not yet been released).

Figure 1.13

More fundamentally, traditional biodiesel does not have the same scale up potential as ethanol, due largely to lack of large-scale feedstock availability as a function of low oil yields per acre of crops such as soy and rapeseed. It has been found that meeting current heating and transportation needs with biodiesel would require as much as one to two times the U.S. land area in soybean production or two-thirds of the U.S. land area for rapeseed production. Moreover, as opposed to algae or cellulosic ethanol, biodiesel requires a more local feedstock because of its reliance on food oils, which have high transportation cost. As a result, investments in renewable diesel replacements have moved towards technologies that address the yield problem by utilizing alternative feedstocks such as algae and sugars that can provide orders of magnitude greater product yields per acre.

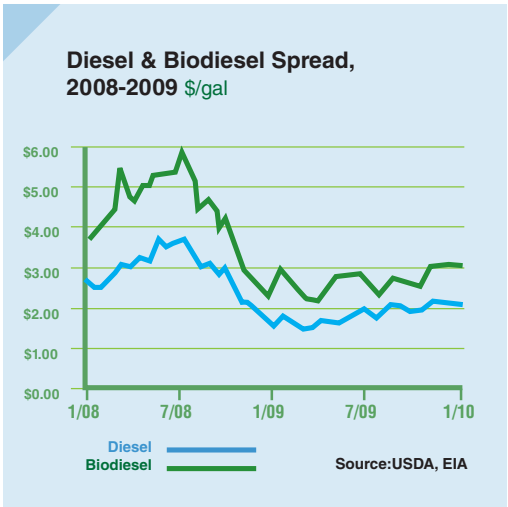
A high profile manifestation of the state of the biodiesel industry is Washington-based Imperium Renewables, whose $88 million 100 million gallon per year Grays Harbor facility lies idle following a series of financial difficulties. The company's $345 million IPO, originally planned for 2007, was sidelined after commodity price fluctuations, regulatory issues and a battle with Societe Generale over a $101 million credit line forced the company to build its new facility using equity. With the cleantech IPO market struggling in 2008 and

2009, the company has recently lost contracts with a number of potential buyers.

New RFS2 regulations will require the use of 500 million gallons of biomass-based diesel in 2009 and 1 billion per year from 2012 through 2022. Seven states (Minnesota, Washington, Oregon, Pennsylvania, Louisiana, New Mexico and Massachusetts) have passed renewable fuel standard ("RSF") egislation requiring the use of biodiesel. A B5 RFS passed the Iowa Senate in 2009 but as of the end of 2009 was still awaiting approval by the House.

Figure 1.14

Figure 1.15



Case Study Midwest Region

The biofuels industry is an increasingly important part of the agro-industrial economy, especially in the rural Midwest. The industry contributes to the economy through operations expenditures, plant construction and R&D, and studies show that it is producing jobs with above-average wages and contributes a positive flow of tax revenues to national, state and local governments. Ethanol industry expenditures totaled $50.9 billion in 2008 and 2009, contributing nearly $119.0 billion to the country's GDP and sustaining an average of nearly 450,000 jobs with above average wages. New plant construction and equipment accounted for $5.3 billion of expenditures, and R&D funding topped $3.4 billion, the majority of which was funded by corporate and private venture capital funds. GDP and household income affects of ethanol industry spending generated tax revenues of $19.3 billion for the federal government and $16.5 billion for local and state governments over the two year period (LECG).

However, there is also downside risk potential. The contributions of the nascent biofuels industry to the economy and the fact that many plants source the majority of their feedstock locally underline why recent plant closures have had such a significant impact on local economies. At the height of industry woes in July of 2009, 23 plants with a capacity of 1.696 billion gallons were idle in the U.S, a majority of which were in the Midwest. While numerous plants have come back on line since then, if this level of production were to remain idle for the entire year, it would mean an acute contraction of local economies by a total of $7.77 billion and could equate to layoffs of more than of 31,500 Americans (Concentric Energies calculations based upon LECG and RFA data).

Idle Plants as of July 2009

Company	State	Capacity (mgy)
VeraSun Energy Corp.	IA	110
AltraBiofuels Indiana, LLC	IN	92
VeraSun Energy Corp.	IN	110
Gateway Ethanol	KS	55
Carbon Green Bioenergy	MI	50
DENCO, LLC	MN	24
Valero Renewable Fuels	MN	110
VeraSun Energy Corp.	MN	110
Alchem Ltd. LLP	ND	10
VeraSun Energy Corp.	ND	110
E3 Biofuels	NE	25
Mid America Agri Products/Horizon	NE	44
Greater Ohio Ethanol, LLC	OH	54
AltraBiofuels Coshocton Ethanol, LLC	OH	60
VeraSun Energy Corp.	OH	110
VeraSun Energy Corp.	SD	110
Pacific Ethanol	CA	40
Pacific Ethanol	CA	60
Pacific Ethanol	ID	50
Abengoa Bioenergy Corp.	NM	30
Sunoco	NY	114
Cascade Grain	OR	108
White Energy	TX	110
TOTAL	**23**	**1,696**

Source: RFA

PROGRESS IN ADVANCED BIOFUELS

DIVERSE TECHNOLOGIES UNDER DEVELOPMENT

2008 and 2009 cautiously witnessed the first cellulosic plants produce products for sale at small volume. Meanwhile, advanced fuels made progress in the lab and at the pilot scale. Algae also got a lot of attention as a response to land use management and efficiency becoming more likely to be included in upcoming legislation and/or regulation.

The U.S. is on a path towards a diverse transportation energy mix that will develop over the next decade. The results of current biofuels efforts have the potential to be the foundation for liquid fuels in the 21st century.

Cellulosic Ethanol Conversion Technologies

Commercial cellulosic ethanol is arguably on the verge of breaking into our fuel system, but the sub-industry continues to search for its identity, influenced by new research and development efforts. To date, most cellulosic ethanol pilot projects and all but one demonstration project use biochemical conversion technology. While biochemical conversion is more understood than thermochemical methods, commercialization of the process faces significant economic challenges that have divided companies in their approaches.

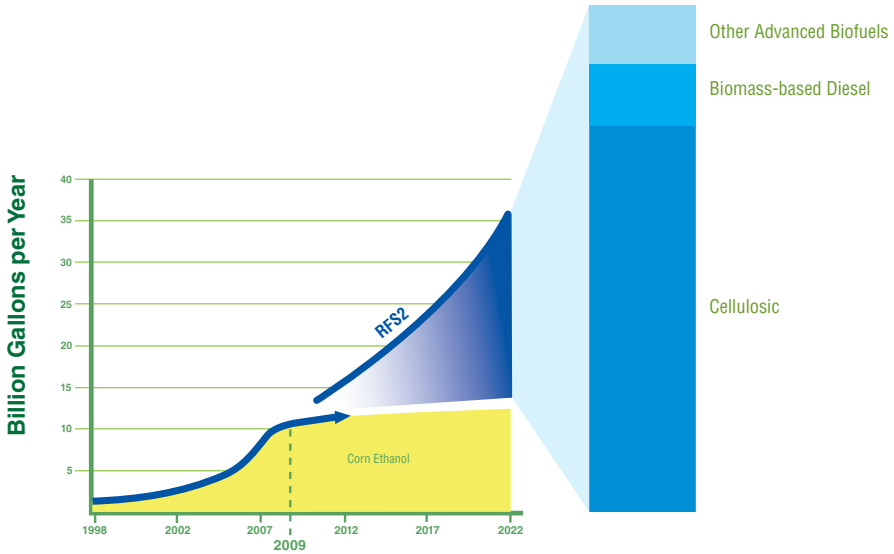
The primary focus of most government and private sector R&D is improving pretreatment technology and developing more cost-effective cellulase enzymes. Despite these advances and the fact that enzyme costs have reduced 30 times over the last five years, the most formidable technical barrier to economical production based on biochemical processes remains the high cost of enzymes to break complex cellulose structures down to sugars.

Most biochemical conversion plants under development, including those of POET, Abengoa, Verenium, and logen, rely on the development of faster, stronger and cheaper enzymes. NREL has for years partnered with enzyme companies, including Novozymes and Genencor, to develop “cocktails” of cellulases to improve the hydrolysis process. And, the DOE is currently

Figure 2.1

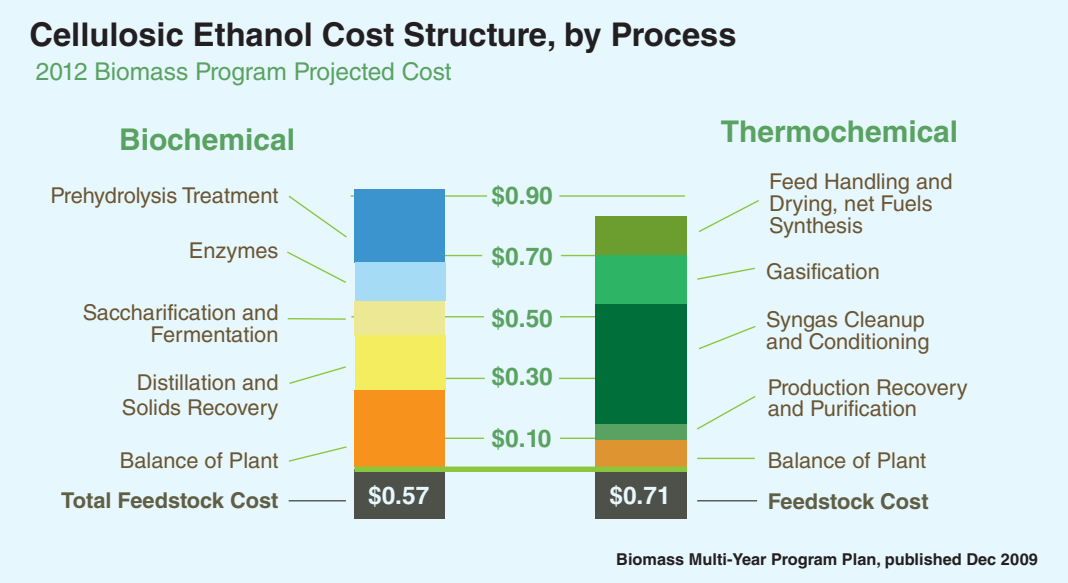
Advanced Biofuels in 2022

RFS2 requires 16 bgpy of cellulosic ethanol and 5 bgpy of other advanced biofuels



Note: RFS2 requires 16 bgpy of cellulosic ethanol and 5 bgpy of other advanced biofuels. Fuel mix in 2022 shown here is illustrative. Exact market shares will be determined by technology and market factors.

Figure 2.2



working with these two companies as well as DSM and Verenium on next generation cellulases through partnerships launched in 2008. Genecor announced the release of second generation enzymes in 2009, and Novozymes has said that it will have reduced the cost by four times before they are commercially released in 2010. Yet even with improved enzymes, byproducts of the hydrolysis process may still inhibit fermentation, which is necessary to convert the sugars into ethanol.

While most companies rely on this multi-step process of pretreatment, hydrolysis and fermentation, others such as Mascoma are attempting to simplify the biochemical conversion process by combining the multiple steps of ethanol production into one. This methodology, called consolidated bioprocessing, received a boost when Mascoma announced in mid-2009 that it had reached major breakthroughs in developing engineered microbes that perform both the hydrolysis and fermentation process. Such advances are bringing such technology substantially closer to commercialization.

A few plants under construction, most notably those of Range Fuels and Coskata, rely on thermochemical conversion technology to convert biomass to syngas (CO + H2) and then employ catalysts to reassemble it into ethanol or other products. With a potential to be more efficient at converting a variety of feedstocks (including biomass with high lignin content), thermochemical conversion still faces its own pressing challenge of syngas clean up and conditioning.

Of the companies nearing commercial production, BlueFire Ethanol, Arkenol, and Masada Resource Group are focused on developing a concentrated acid hydrolysis pretreatment. (Source: DOE EERE)

The RFS2 originally mandated that the nation's fuel mix include 100 million gallons of cellulosic ethanol in 2010, but in February 2010 that mandate was adjusted down to 6.5 million gallons due to the realities of delays in cellulosic plants coming online (EPA). Despite advancements toward commercialization and financial support from public sector programs as well as private investors, it remains to be seen whether enough production will come online in the next fifteen months to meet the quota. While an estimated 300 million gallons of commercial-scale cellulosic ethanol capacity is in various stages of planning and development, there are currently no commercial cellulosic ethanol facilities in the United States. Of the handful of demonstration facilities currently producing worldwide, six plants are operating in the United States, with total capacity of less than 4 million gallons. Several companies with pilot facilities are beginning production over the next two years, but high profile commercial plants from producers including Range Fuels, Coskata and Verenium have faced construction delays. The EPA has acknowledged that the harsh economic climate has had a significant impact on the fledgling cellulosic biofuels industry and may warrant adjustments to the RFS in 2011.

Table 2.1

Currently Operating Cellulosic Ethanol Demonstration Plants

Company	Location	Start Date	Process	Feedstock	Capacity [gal/yr]
Iogen	Canada	Apr 2004	Biochemical	Wheat straw	260,000
BioEthanol Japan	Japan	Jan 2007	Biochemical	Wood waste	370,000
KL Energy Corp	Wyoming	Jan 2008	Biochemical	Wood	1,500,000
Verenium	Louisiana	Mar 2008	Biochemical	Bagasse	1,400,000
AE Biofuels	Montana	Aug 2008	Biochemical	Various	150,000
Mascoma	New York	Feb 2009	Biochemical	Various	200,000
Coskata	Pennsylvania	Sep 2009	Thermochemical	Waste	50,000
Inbicon	Denmark	Nov 2009	Biochemical	Various	1,400,000
Dupont Danisco	Tennessee	Jan 2010	Biochemical	Corn cobs	250,000
				total	**5,580,000**

Source: Company Websites

Next Generation Fuels

Corn and sugar ethanol plus biodiesel remain the base of commercial biofuels in the U.S, Europe, and Brazil, and cellulosic ethanol is on the verge of commercialization. However, due to ethanol's cost structure and energy content, greater attention has been given to new feedstocks (especially algae, addressed below) and developing new pathways to convert biomass into products such as biochemicals, biodegradable plastics and biocrude which can be used in exiting oil refineries. While farther from commercial scale production than cellulosic ethanol, a number of companies are working on advanced molecules including biobutanol, renewable gasoline, renewable diesel and renewable petroleum that offer higher energy contents and greater end use flexibility without corroding engines and pipelines.

Butanol and isobutanol are most similar in chemical composition to ethanol. BP and Dupont have been researching commercial applications for some time, and venture backed Gevo is the most high profile startup working on developing butanol as a direct replacement for gasoline. While less corrosive and more usable as a standalone in conventional engines, butanol still has lower energy content than gasoline. Leading early pioneers of advanced alcohols, including Codexis, to move on to focus more on biopetrol and its derivatives.

One of the most well-funded advanced fuel startups, synthetic biology company Amyris Biotechnologies, has made significant advances working on isoprenoids used in a number of applications by engineering bacteria to transform sugars into myriad useful molecules. Amyris is working to commercialize types of renewable diesel and jet fuel with performance properties matching those of petroleum-based products. With a pilot plant in CA (November 2008) and a demo plant in Brazil (June 2009), the company is also working on renewable chemicals for consumer, industrial, and pharmaceutical markets using the same synthetic biology approach.

LS9, another well-recognized advanced fuels company, has made commercialization progress based on microbes to produce high-carbon fatty acids. The company has engineered a strain of e coli bacteria to convert sugar into a methyl ester with similar structures to existing clean diesel, and is also working on biocrude which could be fed directly into existing oil refineries. LS9's major breakthrough is that its microbes secrete oil substitute without dying, an obstacle many other companies have yet to overcome.

Other companies including Virent and Anellotech, a spinout of University of Massachusetts-Amherst, are also working toward producing high energy content renewable gasoline, diesel and jet fuels. Virent claims that renewable gasoline using its Bioforming process will have

Table 2.2

Operational Advanced Fuels Pilot Projects				
Company	**Date**	**Location**	**Fuel**	**Capacity** [gal/yr]
Cobalt	Jan 2010	California	Biobutanol (Fermentation)	10,000
Gevo	Sept 2009	Missouri	Biobutanol (Fermentation)	1,000,000
Amyris	June 2009	Brazil (& California)	RDIF (CBP)	10,000
LS9	Aug 2008	California	RDIF (CBP)	10,000
Rentech	Aug 2008	Colorado	RDIF (FT)	150,000
Dynamotive	April 2005	Canada	RDIF (Pyrolysis)	10,000
REII	2005	California	RDIF (Gasification)	20,000
			total	**1,210,000**

Source: Biofuels Digest

a 20-30% cost per BTU advantage over ethanol and produces twice the net energy per acre. Like thermochemical cellulosic technology and those of other advanced biofuels, this process can utilize a wider range of feedstocks than current commercial biofuel technologies.

Biodiesel

Biodiesel, defined as fatty acid methyl ester (aka FAME), is most commonly produced from a range of vegetable oils, including soy, palm and rapeseed oil through transesterification. The advantages of biodiesel include its ease of integration into regular diesel engines, and its favorable energy content relative to alcohol-based biofuels. Downsides include poor cold properties and limited shelf life. The FAME production process is widely understood but has shown little scientific advancement in recent years. This is due in part to a greater trend towards alternatives such as renewable diesel, synthetic fuels and algae-based biodiesel which do not necessarily rely on or compete with food crops. The push toward these next generation biofuels is largely driven by land use concerns and the understanding that biodiesel fundamentally lacks sufficient feedstock in order to make it viable at a large scale.

One pathway to "renewable diesel" is hydrocracking plant oils in order to produce hydrocarbons that are directly compatible with petrodiesel. The technology has come online at commercial scale starting in 2006 by large industry players including BP (2007), ConocoPhillips (2006), Neste (2007, 2009), Petrobras (2007) and UOP/Eni (2009).

Recent innovators of advanced diesel replacements are synthetic diesel makers Amyris Biotechnology and LS9, mentioned above, as well as algae-to-energy producer Solix. Start-ups such as these have cost and infrastructure barriers to overcome, but hold promise in their ability to reach the scale needed to materially impact the diesel fuel market in the U.S..

Algae

Previously shunned as a prohibitively expensive technology, algae biofuels have received increasing attention in 2008 and 2009. While still far from commercial development, algae-based fuels have the potential to provide the most land-efficient option for producing biomass-based petroleum alternatives, with future yields approximated at 2,000 to 5,000 gallons per acre per year compared to less than 200 gallons per year possible from the same acreage of jatropha-based cellulosic biofuel. DOE research indicates that an area of 15,000 square miles could sustain enough algae-based fuel production to cover our current level of petroleum consumption.

A number of algae-based fuel companies have capitalized on prevailing concerns about land-use in the industry to gain financial support, and Continental Airlines in January of 2009 successfully ran the first flight of an algae-fueled jet. While

Table 2.3

Operational Algae Fuels Pilot Projects		
Company	**Fuel**	**Capacity** [gal/yr]
PetroAlgae	RDIF (Coking)	120,000
Sapphire Energy	RDIF (Hydroprocessing)	10,000
Solazyme	RDIF (Hydroprocessing)	100,000
Aurora Biofuels	Algae Biodiesel	10,000
ENN	Algae Biodiesel	10,000
LiveFuels	Algae Biodiesel	10,000
Seambiotic	Algae Biodiesel	10,000
Solix	Algae Biodiesel	6,000
	total	**276,000**

Source: Biofuels Digest

Select Algae Biofuels Companies

1. AlgaeLink
2. Algenol
3. Algoil
4. Aquaflow Binomics
5. Aurora Biofuels
6. Bionavitas
7. Blue Marble Energy
8. Bodega Algae
9. Cellena
10. Enhance
11. Envirtrade
12. Green Fuel
13. Green Shift
14. HR Biopetroleum
15. Inventure Chemical
16. Kai Bioenergy
17. Live Fuels
18. Martek
19. Mighty Algae Biofuels
20. Origin Oil
21. Petro Algae
22. Petro Sun
23. Sapphire
24. Seambiotic
25. Solazyme
26. Solena
27. Solix Biofuels
28. Synthetic Genomics
29. Texas Clean Fuels
30. Valcent

only a few firms have raised enough funding to initiate production, venture capital investments in algae biofuels increased in 2008 and 2009 even as less attention was devoted to biofuels overall in 2009. Exxon-Mobil, BP and Valero all invested in algae biofuels in 2009, and Royal Dutch Shell and Chevron have also made high-profile investments since 2007. Exxon-Mobil made the highest single investment in algae biofuels to date, a research and development partnership with San Diego's Synthetic Genomics that will total $300-$600 million dollars.

There are currently over 50 algae biofuels companies active in the U.S., but none are near significant production and the industry remains in a stage of technological development focused on reducing costs. While a few market leaders claim to have the capacity to reach commercial production of algae-based fuels by 2011 or 2012, many technology and economic hurdles must be overcome. However, a number of companies have announced scientific breakthroughs and costs are likely to reduce significantly from the current level. Current cost optimization challenges for algae include:

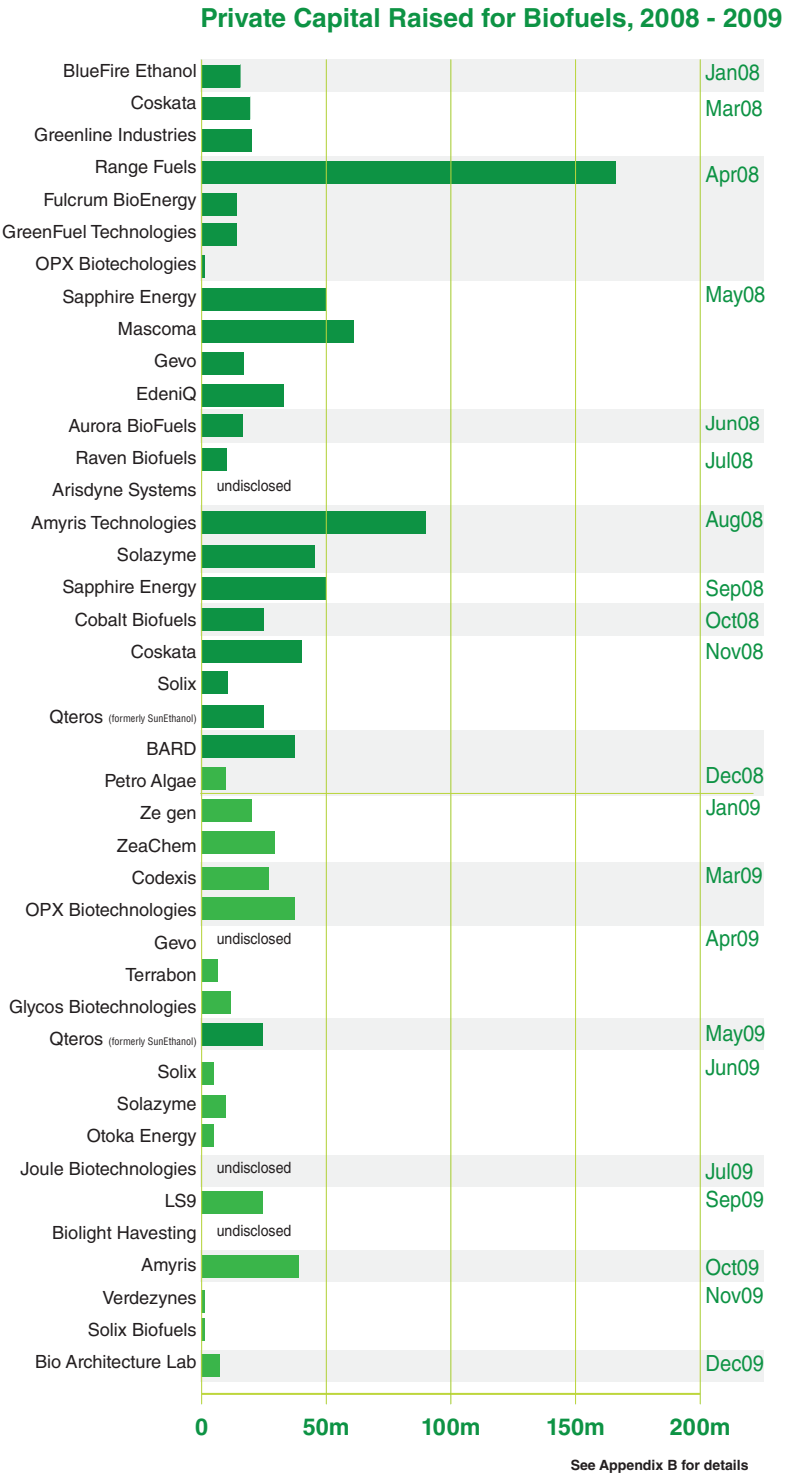
- Maximizing algae species' lipid content to increase oil output
- Establishing optimal growing environments and CO2 concentrations
- Designing efficient mechanisms for de-watering and harvesting the oil produced
- Balancing alternative sources of revenue including carbon sequestration and sales of protein byproducts

Among the large number of companies active in the sector, there is significant diversity of approaches regarding growing environments and processes. Open ponds are widely understood to be the most inexpensive cultivation method at present, although companies continue to advance with other methods including sugar-fueled fermentation and closed photobioreactors. The closure of GreenFuels, previously considered one of the more promising companies in the sector utilizing photobioreactors, likely signals a greater migration toward open-pond and fermentation approaches. It remains to be seen how the market will develop once best practices are established and costs are reduced to a commercially viable level.

CELLULOSIC FEEDSTOCKS AND LAND USE

Advances continue to be made in crop science for cellulosic feedstocks as well as understanding of availability and costs to utilize waste biomass. Large agribusiness companies such as Monsanto and ADM as well as energy crop start-ups like Ceres are pushing ahead to increase crop yields. As cellulosic ethanol producers prepare for commercial launches, they are forced to work out details of supply chain management and locking up resources. As the industry lifts off, these issues will move from the realm of scientific resource studies to core business functions.

Figure 2.4



Business progress aside, work continues to advance the thinking on resource assessment. The "Billion Ton Study", published in 2005 by the DOE and USDA, was a landmark resource assessment showing large cellulosic feedstock potential in the U.S. Although criticized for its limited treatment of indirect land use impacts, it drew a line in the sand and prompted further study by various researchers and institutions.

INVESTMENT TRENDS IN BIOFUELS

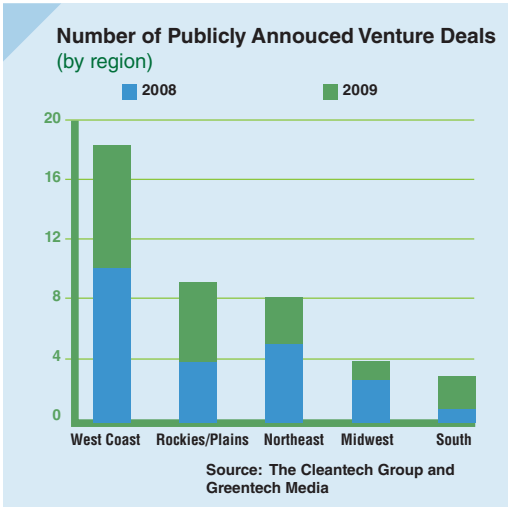
Venture and Growth Capital

Venture capital and private equity investing continued to be driving forces behind the advancement of second, third and fourth generation biofuels in 2008 and 2009. Global biofuels venture capital investment reached an all-time high in 2008 of between $904 and $967 million, according to the Cleantech Group and Greentech Media, respectively. After a record-setting first three quarters of 2008, tight credit markets, commodity fluctuations, and a changing policy environment certainly contributed to a decrease in biofuels and other cleantech investment late in 2008 and into 2009, but investment in the sector seemed to be recovering towards the end of the period. The Cleantech Group estimated that biofuels received $554 million in venture investment in 2009.

The U.S. was the primary market for biofuels investment in both years. Appendix B and figures in this section focus on major venture- stage investments in U.S. biofuels.

As shown in Table 2.4, deal sizes tended to be larger and more numerous in 2008. This reflects decisions by many biofuels investors to scale up their contributions to portfolio companies as they moved toward project development and commercial-scale production phases. The average deal size dropped significantly in 2009 to $16.6 million from its 2008 high of $34.1 million, but remained above 2007 levels. In addition to notable large follow-on investments in established cellulosic ethanol companies, much of the new venture capital money in 2008 and 2009 went to algae and hydrocarbon fuel technologies. This trend implies a recognition in the investment community of issues related to feedstock availability, environmental footprint, and infrastructure compatibility of biofuels.

Figure 2.5



As in previous years, the location of venture investments in 2008 and 2009 was skewed towards traditional sources of venture investment and progressive environmental policies. California and the West Coast once again led the nation, with 18 of the 42 publicly announced venture deals located in that region. The Rockies/Plains region and Northeast also outpaced more traditional agricultural production areas of the Midwest and the South, though large scale project development seems to be concentrating in the latter areas.

Biofuels continued to attract interest from traditionally strong cleantech venture capital investors, and the period witnessed the launch of a number of new cleantech-focused funds that promise to contribute capital to the sector well into the decade, including a $500 million green growth fund launched by Kleiner Perkins in 2008 and $250 million early stage and $750 million growth funds launched by Khosla Ventures in 2009. The period also saw the introduction of many new venture investors to the space, with a drastic increase in the number of investing firms to nearly 70 in 2008. Notable among newer entrants are Flagship Venture Partners and Valero Energy.

Refer to Appendix B for more imformation on venture capital

Oil Companies Get in the Game

Valero's involvement reflects a major investment trend of 2008 and 2009, which is an important increase in biofuels participation by major oil companies, including both commercial projects and traditional research and development roles. While renewable fuel standards and other policy incentives are forcing oil companies to accommodate biofuels, the struggling economy has left a number of ethanol companies bankrupt and plants idle, opening the door for cheap acquisition of assets.

Oil companies are focusing on both first generation ethanol assets to meet current RFS requirements as well as more long term investments in advanced biofuels. Most noteworthy are Valero's $737 million purchase of nine VeraSun ethanol plants in March of 2009 and ExxonMobil's $600 million investment in an algae biofuels partnership with Synthetic Genomics announced in May of 2009. These two deals are of particular interest as both Valero and ExxonMobil are new entrants in the biofuels space, long trailing BP, Royal Dutch Shell and Chevron. Valero also made several early stage investments in advanced fuels companies including algae

Refer to Appendix C for more information on oil company investments

Table 2.4

2008-2009 Venture Capital Statistics			
	2007	2008	2009
Number of Deals	34+	23+	18+
Investment Size Range	$250k - $70m	$2.6m - $166m	$1m - $42m
Mean	$15.8m	$34.1m	$16.6m
Median	$7.1m	$20.0m	$11.6m
Number of Active Firms	43+	67+	40+
Top investors in 2008 & 2009		**2008**	**2009**
Khosla Ventures		6	2
Mohr Davidow Ventures		1	2
Valero		1	4
KPCB		3	1
Flagship Venture Partners		1	3
Vantage Point		2	2
Harris & Harris		2	1
Lightspeed		1	2
Braemar Energy Ventures		1	2
X/Seed Capital Management		1	2

Source: The Cleantech Group & Greentech Media

company Solix, cellulosic ethanol players Qteros and Zeachem, and hydrocarbon fuels producer Terrabon.

With few exceptions, until recently, most oil companies preferred to limit their involvement in biofuels to R&D funding, while keeping commercial projects at a distance from their core business operations. BP is the clear leader in R&D funding after spending $500 million to launch the Berkeley-based Energy Biosciences Institute (EBI) in 2008, but Exxon-Mobil, Royal Dutch Shell, Chevron and ConocoPhillips have all funded external biofuels research as well. Shell announced research agreements in 2008 with six top academic institutions around the world including MIT and the Chinese Academy of Sciences.

With the political, economic and scientific environments changing, each of the oil majors with significant U.S. presence has announced involvement in a commercial biofuels project in the last two years. Shell's role as a leader among its peers in commercial biofuels remains strong, as it recently increased its stake in Canadian wheat straw ethanol producer Iogen, launched a Brazilian sugar ethanol joint venture with Cosa, and has expanded its presence into enzymes, algae, biogasoline and biomass to liquids through investments in Codexis, HR Biopetroleum, Virent Energy Systems, and Germany's Choren, respectively. BP expanded its joint venture with microbe partner Verenium in 2009 to begin building a commercial cellulosic ethanol plant in Florida. The company has cut off its jatropha relationship with British company D1 Oils but continues to focus on biobutanol through a partnership with Dupont and British Sugar, and sugar ethanol with Brazilian ethanol venture Tropical BioEnergia. The company has also invested in cellulosic ethanol company Qteros as well as algae R&D with Martek Biosciences.

Chevron has recently made new investments in a number of research institutions as well as algal biofuels company Solazyme, renewable diesel producer LS9, a feedstock sourcing agreement with Mascoma, and a cellulosic ethanol joint venture with Weyerhaeuser. However, it is currently facing a lawsuit from its partner Galveston Bay Biodiesel for allegedly backing out of funding agreements for a biodiesel plant in Texas. Marathon, Conoco-Phillips and Total have been active equity investors in biocrude and biobutanol, respectively, while Sunoco and Murphy Oil

have been more active as equity investors in commercial ethanol projects. Houston-based Marathon has made investments in cellulosic ethanol company Mascoma as well as a joint venture with The Andersons. It has also completed two biodiesel storage and distribution projects.

While big oil's investments in biofuels are increasing, they still make up at most 3-4% of the companies' annual capital expenditures. However, the increase in spending is far from insignificant. A study at Austin's Center for Energy Economics found that between 2000 and 2008 the U.S.-based oil and gas industry invested $6.7 billion in non-hydrocarbon technologies, including wind, solar and biofuels, and this is likely to increase as policy trends continue to support renewables and asset prices stay low. Along with long-term stability in renewable fuel standards, big oil's involvement may add stability to the industry, especially as biofuels companies grow into the capital intensive phase of building commercial projects, thus taking them out of the venture capital realm. It is likely that as more cellulosic startups mature and prove their economic viability, oil players will become more involved in project development and asset management.

Public Equity Markets

The public equity markets represent a source of capital for project development and fleet growth, but have struggled along with the rest of the economy during the downturn. As a result of this and other factors, there are still relatively few pure play ethanol stocks. See also Financial Health of the Industry section in Chapter 1.

THE U.S. GOVERNMENT AS VENTURE CATALYST

While the biofuels industry has seen rough times in 2008 and 2009, there continues to be substantial financial support from the U.S. government. President Barack Obama, in his "New Energy for America" plan, called for a federal investment of $150 billion over the next decade to catalyze private efforts to build a clean energy future. Sustainable biofuels are called out to be part of the portfolio, particularly in the context of consistent messaging across administrations. Energy independence and security as well as economic growth and job creation are goals. By these measures, biofuels have been a productive investment in new ventures:

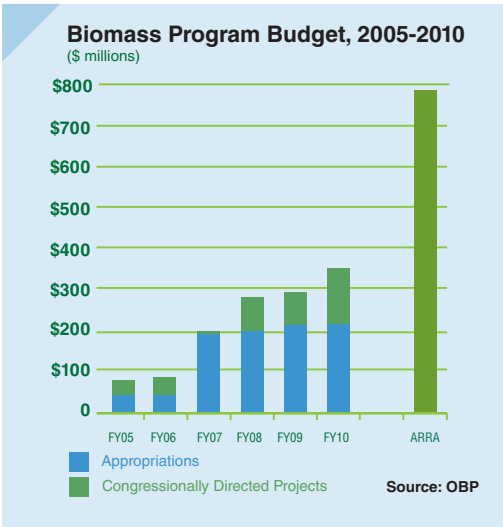
- In 2008, the industry displaced 321.4 million barrels of oil and is likely to displace a cumulative total of 10.97 billion barrels of oil between 2009 and 2022, at which point biofuels are predicted to make up 30% of U.S. motor fuel supply.
- In terms of economic impact, total expenditures will add $1.23 trillion to GDP over the course of the next fourteen years, support 1.18 million jobs throughout the economy, and contribute tax revenues to local, state and federal governments totaling $390 million.

The President has also formed the Biofuels Interagency Working Group in order to bring together the USDA, DOE and EPA to develop a comprehensive biofuels market development program, formulate policies to increase flexible fuel vehicle production, and evaluate land use, conservation, resource management, and greenhouse gas emissions considerations related to biofuels.

DOE and ARRA Funding

With funding from the American Recovery and Reinvestment Act of 2009 (aka, the Stimulus Package, or ARRA), the DOE continues to play an instrumental role in the development of the biofuels industry. The ARRA provided $786.5 million in funds to support renewable fuels, current details of which can be found on the DOE website.

Figure 3.1



USDA Funding

The 2008 Farm Bill provides loan guarantees for commercial-scale biorefineries and grants for demonstration-scale biorefineries that produce advanced biofuels—defined as fuels that are not produced from food sources. The loan guarantees can be used to develop, construct and retrofit viable advanced biofuels biorefineries. The maximum loan guarantee under the program is $250 million per project.

In May 2009, President Obama issued a presidential directive to USDA to expedite the process of issuing the remaining loan guarantees as well as awarding of facilities construction grants and refinancing of existing investments in renewable fuels.

USDA awarded the first loan guarantee to a commercial scale cellulosic ethanol plant, as a conditional commitment for an $80 million Range Fuels' facility in Georgia. The first phase of the project is under construction and scheduled to begin production in 2010. Range is also a beneficiary of the DOE grant program, winning a grant award of $76 million in early 2007, highlighting the positive interaction between DOE and USDA.

U.S. ETHANOL INDUSTRY: 28 COMPANY PROFILES

	Company	Category	Ownership
1	Archer Daniels Midland	Ag/Bio/Chem	Public
2	Danisco	Ag/Bio/Chem	Public
3	DuPont	Ag/Bio/Chem	Public
4	Monsanto	Ag/Bio/Chem	Public
5	NewPage	Ag/Bio/Chem	Private
6	Novozymes	Ag/Bio/Chem	Public
7	Abengoa Bioenergy	Producer/Marketer	Public
8	Aventine Renewable Energy	Producer/Marketer	Public
9	Green Plains	Producer/Marketer	Public
10	POET	Producer/Marketer	Private
11	BlueFire Ethanol	Growth Stage	Public
12	Coskata	Growth Stage	Private
13	Flambeau	Growth Stage	Private
14	Lignol Innovations	Growth Stage	Private
15	Mascoma	Growth Stage	Public
16	Pacific Ethanol	Growth Stage	Public
17	Range Fuels	Growth Stage	Private
18	Verenium	Growth Stage	Public
19	BP	Integrated Energy	Public
20	Chevron	Integrated Energy	Public
21	Royal Dutch Shell	Integrated Energy	Public
22	Valero	Integrated Energy	Public
23	Bateman Litwin	Services	Public
24	CH2M HILL	Services	Private
25	Fagen	Services	Private
26	ICM	Services	Private
27	CoBank	Finance	Private
28	Khosla Ventures	Finance	Private

Notes:

1. Companies highlighted in green were DOE grant selectees. Due to timing of announcements and scope of initial coverage, not all selectees are profled in this report.
2. Financial data for the two year period ending December 2009 except where noted. Market cap as of December 31, 2009.
3. Sources: Company reports, websites, press releases, stock price data and other publicly available information.

ARCHER DANIELS MIDLAND

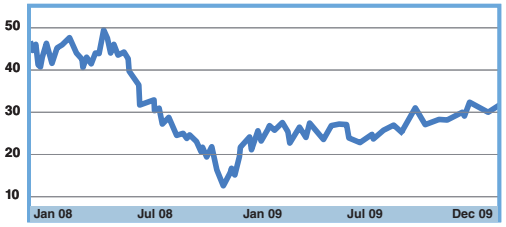
Segment: Conversion
Location: Decatur,IL
Ownership: Public

Key Financial Metrics:
Revenue: $140.5 b
Net Earnings: $3.7 b
Net Margin: 2.6 %
Market Cap: $20.1b

ADM's strategy is to leverage its supply, technical and financial strength advantages to enjoy economies of scale for production. The company currently operates five ethanol plants in the U.S. and will become the country's largest ethanol distiller once two new plants in Nebraska and Iowa begin production. ADM also has biodiesel production capacity of 450 million gallons across five countries

Archer Daniels Midland Company, "ADM", is engaged in logistics, processing, and merchandising of agricultural commodities and products. It is involved in biodiesel and ethanol conversion and also maintains a national transportation system including rail, trucks, barges and storage facilities

NYSE: ADM | Jan 2008- Dec 2009



Selected Headlines:

- In November 2008, ADM and Grupo Cabrera announced a $500 million joint venture to construct two processing complexes in Brazil to produce ethanol from sugarcane.
- In December 2009, ADM was granted $24.8 million in Recovery Act funding from the DOE for a pilot-scale facility to use acid to break down biomass to produce both ethanol and ethyl acrylate.

DANISCO

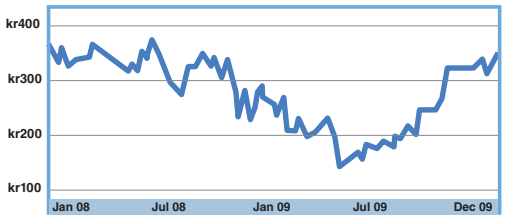
Segment: Enzymes
Location:
HQ:Copenhagen, DK
U.S: Palo Alto, CA
Ownership: Public

Key Financial Metrics:
Revenue: $4.8b
Net Earnings: $31.2m
Net Margin: 0.7 %
Market Cap: $3.0m

Genecor, a Division of Danisco, USA, Inc., discovers, develops, and sells enzymes to the agricultural processing, industrial processing, and consumer products industry. While ethanol is a small part of Danisco's portfolio, the company is the second largest supplier of enzymes to the ethanol industry with R&D programs in place to further advance the biological pathway for biofuel product

Danisco is a Danish ingredient and biotechnology company focused on developing, producing and marketing traditional food ingredients as well as industrial biotech products. The company entered the enzymes business by acquiring Genecor in 2005.

CPH:DCO | Jan 2008- Dec 2009



Selected Headlines:

- DuPont Danisco Cellulosic Ethanol, a joint venture of Danisco and Dupont, was announced in May 2008. The company is headquartered in Illinois and is building a cellulosic demonstration plant in Tennessee.
- In March of 2009, Genencor launched a new generation of its cellulosic ethanol enzyme, Accellerase 1500. The company claims that the enzyme will significantly reduce hydrolysis costs.

Notes:
Income Data for two year period, Feb 2008 - Jan 2010, excluding discontinued operations

DUPONT

DuPont is a diversified materials and products company with activities in agriculture and bio-based materials. DuPont owns leading corn seed producer Pioneer Hi-Bred.

NYSE:DD | Jan 2008- Dec 2009

Segment: Seeds, Conversion
Location: Wilmington, DE
Ownership: Public

Key Financial Metrics:

Revenue:	$59.2b
Net Earnings:	$3.8b
Net Margin:	6.4%
Market Cap:	$30.4b

DuPont approaches the biofuels market as a supplier as well as a potential future producer. The company is a market leader in differentiated seed products and crop protection chemicals. DuPont is pursuing cellulosic ethanol technologies together with POET and biobutanol as a next generation biofuel together with BP.

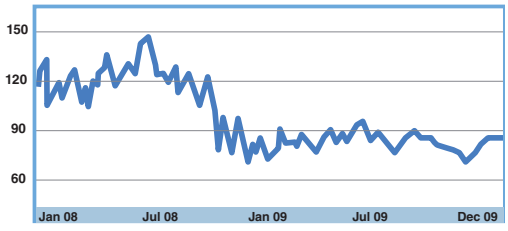
Selected Headlines:

- In July 2008, the DuPont Danisco Cellulosic Ethanol LLC joint venture announced that it would build a cellulosic ethanol pilot and demonstration facility in partnership with the University of Tennessee.
- In August 2008, the EU approved a joint venture between Dupont and BP, the latest step in the two companies' joint development and commercialization of production.

MONSANTO

Monsanto is the world's leading producer of genetically modified seeds. The company has two business units seeds and genomics, which employs modern biotechnology, and agricultural productivity, which includes crop protection products.

NYSE:MON | Jan 2008- Dec 2009



Segment: Seeds, Ag Inputs
Location: St Louis, MO
Ownership: Public

Key Financial Metrics:

Revenue:	$22.7b
Net Earnings:	$3.9b
Net Margin:	17.0 %
Market Cap:	$44.6b

Monsanto is developing new strains of corn seed to increase crop yields up to 300 bu/acre from today's ~150 bu/acre average and plans to develop new sugarcane varieties for biofuels production by 2016. The company has also invested in Mendel Biotechnology to support the development of energy crops and seeds to support the cellulosic biofuels industry.

Selected Headlines:

- In November 2008, Monsanto acquired Brazilian company Aly Participacoes Ltda. and its sugarcane breeding and technology subsidiaries, CanaVialis S.A. and Alellyx S.A. for $290 million.
- In February 2009, Monsanto announced a partnership with ADM and Deere & Co. to conduct research on the economic viability of gathering corn stover for potential ethanol production.

Notes:
Income Data for two year period, Dec 2007 - Nov 2009

NEWPAGE

NewPage Corporation is the largest manufacturer of coated paper in North America. The company arose through MeadWestvaco's sale of its paper busines to Cerberus Capital. The company is privately owned and currently operates ten paper mills throughout the United States and Canada.

Segment: Conversion
Location: Miamisburg, OH
Ownership: Private

Key Financial Metrics:

Revenue:	$7.5 b
Net Earnings:	-$457m
Net Margin:	-6.1%

NewPage is building a small-scale renewable diesel biorefinery in Wisconsin Rapids, WI with $30 million in financial assistance from the Department of Energy. Stora Enso North America, which NewPage acquired in 2007, originally submitted the proposal.The proposed refinery is to produce 5.5 million gallons of fuel per year from the mill's residues and wood chips and will be completed in 2012

Selected Headlines:

- In July of 2009 NewPage announced that it would discontinue work on an ethanol refining facility in Escanaba, MI.

NOVOZYMES

Novozymes is a leader in the R&D and production of enzymes, microorganisms, and biopharmaceutical products. The company produces over 600 products that are used in the production of thousands of industrial processes including biofuel, detergents, feed, and crops.

Segment: Enzymes
Location: Bagsvaerd, DNK
Ownership: Public

Key Financial Metrics:

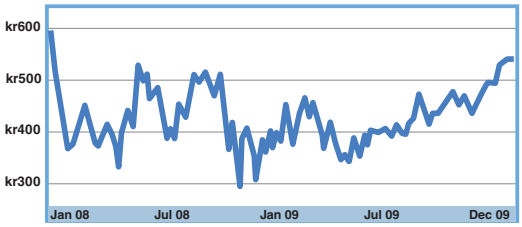
Revenue:	$3.0b
Net Earnings:	$411.2m
Net Margin:	13.6%
Market Cap	$534m

Novozymes is the largest supplier of enzymes to the fuel ethanol industry. The company utilizes gene sequencing technology and bioinformatics to advance its product performance.

Selected Headlines:

- In October of 2008, Novozymes announced its largest R&D project in company history to reduce the cost of producing cellulosic ethanol from corn stover. The DOE is contributing $12.3 million for the project.
- In February 2009, Novozymes, Sinopec and COFCO announced a partnership to produce commercial-scale cellulosic ethanol from corn stover in China by 2010.

Copenhagen: NZYM.CO
Jan 2008- Dec 2009



Notes:
Income Data for 21 month period, April 2008 - Dec 2009, adjusted to reflect October 2008 merger with VBV

Producer/Marketer

ABENGOA BIOENERGY

Abengoa is a Spanish technology company addressing sustainable development in the infrastructure, environment and energy sectors. Abengoa Bioenergy is one of the company's five operating units, the others of which are environmental services, industrial engineering and construction, information technology, and solar.

Segment: Conversion
Location:
HQ:Madrid, Spain
U.S: Chesterfield, MO
Ownership: Public

Key Financial Metrics:

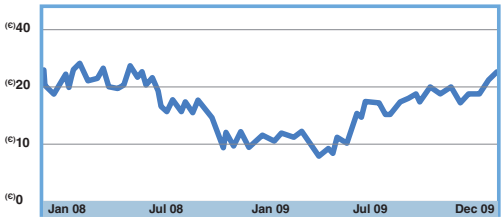
Revenue:	$10.7b
Net Earnings:	421.5m
Net Margin:	3.9%
Market Cap	$2.8b

Abengoa Bioenergy owns and operates six ethanol plants (4 in operation, 2 to begin operation in 2010) and three "new technology plants" in the U.S. The company has spent more than $60 million on cellulosic ethanol pilot plants in Nebraska and Spain. Abengoa also provides ethanol trading services including a mix of short and long term contracts and differential pricing structures. Abengoa Bioenergy made up approximately 25% of the parent company's revenue in 2008 and 2009.

Selected Headlines:

- Abengoa closed a small New Mexico ethanol plant in October of 2008 due to economic constraints, but continues to advance on its Illinois plant, to be completed in late 2009.
- Abengoa's 2007 DOE financial assistance recipient enzymatic hydrolysis demonstration-scale plant in Kansas using agriculture waste is expected to open in 2012.

MCE:ABG | Jan 2008- Dec 2009



Producer/Marketer

AVENTINE RENEWABLE ENERGY

Aventine Renewable Energy Holdings, Inc. is a producer, marketer and end-to-end distributor of ethanol to energy companies in the United States. Aventine is also a marketer and distributor of related by-products as well as biodiesel.

Segment: Conversion
Location: Pekin, IL
Ownership: Public

Key Financial Metrics:

Revenue:	$2.843b
Net Earnings:	-$93.4m
Net Margin:	-3 %
Market Cap:	$15.8b

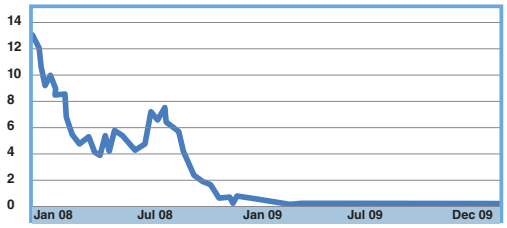
Aventine's business model includes production of ethanol, marketing alliances with other ethanol producers and purchase/resale operations.

Aventine markets and distributes nearly four times as much ethanol as it produces. However, the majority of profits come from ethanol production. Additional marketing activities are high volume/low profit, but are considered a high value strategic activity.

Selected Headlines:

- Aventine was removed from the NYSE in March of 2009 due to its low market capitalization, and filed for Chaper 11 bankrupcy in April, shortly after haulting construction of two biorefineries.
- The company publicly began soliciting potential investor interest in May of 2009 in order to recapitalize or sell its business. As of December 31, 2009, no company had yet to acquire Aventine.

NYSE:AVR | Jan 2008- Dec 2009



Producer/Marketer

GREEN PLAINS RENEWABLE ENERGY

Segment: Conversion
Location: Brookings, SD
Ownership: Public

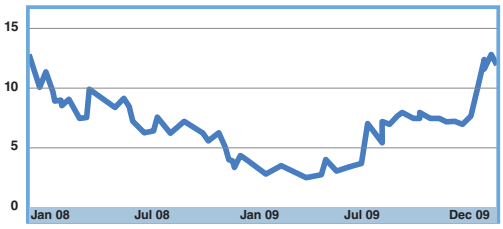
Key Financial Metrics:

Revenue:	$1.5b
Net Earnings:	$12.1m
Net Margin:	0.8 %
Market Cap:	$371.2b

Green Plains is a vertically-integrated ethanol producer. The company operates 6 plants across the Midwest. Green Plains also operates an ethanol marketing business, Green Plains Trade, with over 300 million gallons under contract per annum, and an agribusiness services subsidiary, Green Plains Grain, with grain storage capacity of 20 million bushels. The company is also part of an algae fuels joint venture called BioProcessAlgae, LLC.

Green Plains is the fourth largest ethanol producer in North America, with a capacity of approximately 480 million gallons per year. It has expanded its vertical integration and scale through a merger with VBV in October of 2008 and numerous acquisitions in 2009.

NYSE: GPRE | Jan 2008- Dec 2009



Selected Headlines:

- In January of 2009, Green Plains acquired a majority interest in biofuel terminal operator Blendstar. Blendstar's annual throughput capacity is approximately 250 million gallons.
- Green Plains became the fourth largest ethanol producer in North America in May of 2009 by purchasing two Nebraska mills from bankrupt VeraSun for $123.5 million

Notes:
Income Data for 21 month period, April 2008 - Dec 2009, adjusted to reflect October 2008 merger with VBV

Producer/Marketer

POET

Segment: Conversion
Location: Sioux Fall, SD
Ownership: Private

POET is an integrated ethanol producer, and its business model relies on local ownership and investors, local employees and local corn supply. The company's $200 million "Project Liberty" initiative is pursuing cellulosic conversion of corn cobs, largely to be co-located at existing plants. POET is concentrated in the Midwest region but is beginning to expand outward through services. It received DOE financial assistance of up to $100 million in 2007

POET has 26 ethanol plants in seven states. Activities include development, design, engineering, construction, management and marketing. The Company is the largest ethanol producer in the U.S., currently producing nearly 1.5 million gallons per year.

Selected Headlines:

- In early 2009, POET began operating its $8 million, 20,000 gallon-per-year cellulosic ethanol pilot facility in Scotland, S.D. The process is estimated to be commercially operational by 2011.
- In June 2009 POET launched POET Biomass, a new division encompassing Project Liberty and dedicated to managing its development of second generation biofuels.

Notes:
Income Data estimated for one year period, Jan - Dec 2008

Growth Stage

BLUE FIRE ETHANOL

Blue Fire Ethanol plans to produce ethanol from opportunistic sources of cellulose using advanced biological pathways. It currently has one project awaiting construction and another in the permitting stage of development.

Segment: Conversion
Location: Irvine, CA
Ownership: Public

Key Financial Metrics:

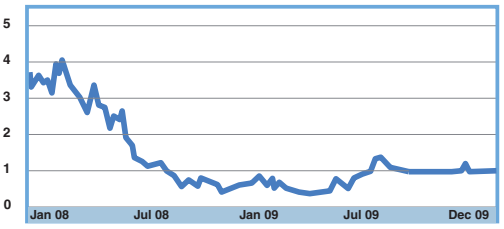
Revenue:	$5.2m
Net Earnings:	-$18m
Net Margin:	-343 %
Market Cap:	$28.3m

BlueFire uses an improved concentrated acid hydrolysis process to convert cellulose to ethanol from wood wastes, urban trash (post-sorted MSW), rice and wheat straws andother agricultural residues. The company has operated a pilot plant near its Southern California offices for roughly five years. Since 2003, the technology has also been successfully used by an unrelated, independent company in Japan to produce fuel ethanol for the local market.

Selected Headlines:

- In July of 2009, Blue Fire completed the 20-month licensing process for its first biorefinery, a 3.2 million gallon cellulosic plant in Lancaster, CA. The company is still awaiting financing for construction. In December of 2009, BlueFire received an additional $81 million DOE grant to construct a 19 million gallon cellulosic ethanol plant in Fulton, MS. The DOE had previously announced $7 million in funding.

OTC:BFRE | Jan 2008- Dec 2009



Notes:
Income Data for two year period, Oct 2007 - Sept 2009

Growth Stage

COSKATA

Started in 2006 by two partners from GreatPoint Ventures, Coskata is of the only major cellulosic ethanol companies focusing on hybrid process conversion. The company's three-step process includes gasification, biofermentation and separations.

Segment: Enzymes, Conversion
Location: Warrenville, IL
Ownership: Private

Coskata builds off of syngas technology and ethanol research taking place at Oklahoma State University and the University of Oklahoma. In Coskata's process, a wide variety of biomass feedstocks including urban and agricultural waste is gasified, then sent to a bioreactor to produce ethanol.

Selected Headlines:

- In late 2008 and early 2009 Coskata announced partnerships with GM and ICM and received funding from a variety of investors to develop a commercial-scale cellulosic ethanol plant by 2010.Despite setbacks with its commercial-scale plant, Coskata's 50,000 gallon a year pilot plant in Madison, PA, began producing cellulosic ethanol in the summer of 2009.

Growth Stage

FLAMBEAU RIVER BIOFUELS

Flambeau River Papers is planning to become the first fossil fuel-free integrated pulp and paper mill in North America. The company took over an antiquated mill in 2006 and currently produces recycled, uncoated free-sheet fine printing and writing papers.

Segment: Conversion
Location: Park Falls, WI
Ownership: Private

The Flambeau River Biorefinery project will be one of the first examples of a modern U.S.-based pulp mill with the ability to produce cellulosic ethanol. The plant will be designed to produce renewable diesel and wax. While much of the feedstock will be spent pulping liquor from the neighboring paper mill, the plant will require additional forest residues to reach full capacity.

Selected Headlines:

- In July of 2008 Flambeau River BioFuels received approval from the DOE for a $30 million grant to construct and operate a forest residue biorefinery at its pulp and paper mill.

Growth Stage

LIGNOL INNOVATIONS INC.

Lignol Energy Group is engaged in the development of biorefineries for the production of fuel-grade ethanol and other biochemical co-products from cellulosic biomass feedstocks.

Segment: Conversion,
Location: Vancouver, BC
Ownership: Public

Key Financial Metrics:

Revenue:	$0
Net Earnings:	-$20.3 m
Market Cap:	$12.8 m

Lignol is commercializing cellulose to ethanol process technology from renewable and readily available biomass. The technology is based on original 'Alcell' biorefining technology that was developed by General Electric and Repap Enterprises and uses a proprietary solvent pretreatment process integrated with saccharification, fermentation and product recovery processes. The company has established a Cellulosic Ethanol Development Centre in Vancouver which consists of a pilot plant and a state of the art enzyme development laboratory.

Selected Headlines:

- In September 2010 Lignol announced that approximately $4 million had been obligated by DOE for Phase 1 of a $30 million agreement with DOE relating to construction of a commercial demonstration cellulosic ethanol plant.
- In June of 2009 Lignol completed the first end-to-end production of cellulosic ethanol from its fully integrated industrial-scale biorefinery pilot plant in Burnaby, British Columbia.

TSX-V | Jan 2008- Dec 2009

Notes:
Income Data for two year period, Feb 2008 - Jan 2010

Growth Stage

MASCOMA

Mascoma develops advanced cellulosic ethanol technologies across a range of cellulosic feedstocks. The company recently relocated its headquarters from Boston, MA to Lebanon, NH. Mascoma has received a $26.0 million DOE grant and $23.5 million in funding from the state of Michigan for the development of a 40 million gallon-per-year Demonstration-scale production facility in Kinross, MI, as well as a $4.9 million DOE grant in 2007.

Segment: Conversion
Location: Boston, MA
Ownership: Private

Mascoma is pursuing a strategy of technology discovery, development and deployment while building a broad intellectual property portfolio and network of research and commercial partners. Mascoma's single-step celluloseto-ethanol method, called Consolidated Bioprocessing, uses proprietary microbes and enzymes and aims to reduce cost.

Selected Headlines:

- In February of 2009, Mascoma's Rome, NY cellulosic ethanol demonstration facility began production. The facility has a production capacity of up to 200,000 gallons of cellulosic ethanol per year.
- Mascoma signed a feedstock sourcing deal with Chevron Technology Ventures in September of 2009 by which Chevron will supply feedstocks to Mascoma and evaluate the results of the conversion process.

Growth Stage

PACIFIC ETHANOL

Pacific Ethanol, through its subsidiaries, produces and sells ethanol and its co-products, and also markets ethanol from other producers. The company has four plants with a production capacity of 200 million gallons-per-year and a minority interest in a 50 million gallon-per-year facility in Colorado.

Segment: Conversion,
Location: Sacramento, CA
Ownership: Public

Key Financial Metrics:

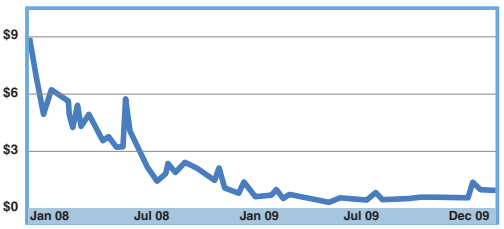
Revenue:	$1.1b
Net Earnings:	-$227.1 m
Net Margin:	-21.4%
Market Cap:	$40.9m

Pacific Ethanol is the largest U.S. ethanol producer on the West Coast. The company's markets include California, Nevada, Arizona, Oregon, Colorado, Idaho and Washington. As of December of 2009, only one of its four facilities was operating. The company received a $24.32 million grant from the DOE in February of 2008 to build a cellulosic ethanol demonstration plant in Boardman, OR.

Selected Headlines:

- Pacific Ethanol received court approval to restart its 60 million gallon-per-year Magic Valley plant in Burley, ID, in December of 2009. Its plants in Stockton, CA and Madera, CA remain idle.
- In May 2009, Pacific Ethanol's producing subsidiaries filed for Chapter 11 bankrupcy. The parent company and its marketing, distribution, and development subsidiaries did not file for Chapter 11.

NASDQ:PEIX | Jan 2008- Dec 2009



Notes:
Income Data for two year period, Oct 2007 - Sept 2009

Growth Stage

RANGE FUELS

Range Fuels is an early stage biofuels company utilizing a two-step thermochemical process to convert multiple cellulosic biomass sources to fuel-grade cellulosic ethanol and methanol. The company operates a first-of-its-kind fully integrated pilot plant at its Development Center in Denver, CO. While it broke ground on its DOE grant-backed first commercial plant in November of 2007, plant construction faced delays in 2008 and 2009.

Segment: Conversion
Location: Broomfield, CO
Ownership: Private

Range Fuels uses a highly efficient thermochemical process. The process is able to handle a wide range of carbon-containing feedstocks including woody biomass, agricultural residues and municipal solid wastes. Range Fuels has received $52 million of a $76 million award from DOE.

Selected Headlines:

- In November of 2008, Range Fuels hired David C. Aldous to replace Mitch Mandich as CEO. Aldous is a former executive vice president at Royal Dutch Shell and president of Shell Canada Products.
- In January of 2009, the USDA awarded the company an $80 million loan guarantee to assist construction of its 100 million gallon cellulosic ethanol plant near Soperton, Georgia.

Growth Stage

VERENIUM

Verenium Corporation is developing and commercializing next-generation cellulosic ethanol. Verenium was formed in June 2007 through the merger of Diversa, a developer of enzyme technology, and Celunol, a developer of cellulosic ethanol process technologies.

Segment: Enzymes, Conversion
Location: San Diego, CA
Ownership: Public

Key Financial Metrics:

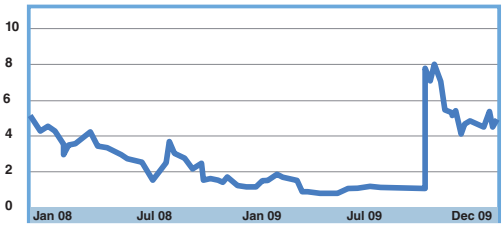
Revenue:	$135.6m
Net Earnings:	-$245.2
Net Margin	-181%
Market Cap:	$52.7m

Verenium has its roots in drug discovery and has partnered extensively in order to move into the biofuels market. The company operates a pilot cellulosic ethanol facility located in Jennings, LA and expects its first commercial unit to be operational in early 2012. $14.9 million of DOE funding went to Verenium's Jennings, LA pilot facility. The company continues to develop enzymes for food-related and other industries.

Selected Headlines:

- As part of the Galaxy Biofuels partnership established in August of 2008, BP agreed to pay Verenium $90 million over 18 months for the rights to Verenium's cellulosic ethanol technology.
- From February to July of 2009, Verenium and BP expanded their agreement into a 50-50 joint venture called Vercipia to develop a commercial-scale cellulosic ethanol plant in Highlands County, FL.

NADAQ:VRNM | Jan 2008- Dec 2009



BP

BP is a global integrated energy company with three business segments: Exploration and Production, Refining and Marketing and Gas, and Power and Renewables.

Segment: Conversion
Location: London, UK
Ownership: Public

Key Financial Metrics:

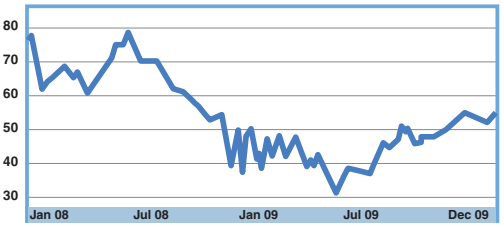
Revenue:	$613.2 b
Net Earnings:	$38.4 b
Margin:	6.3 %
Market Cap:	$180.9 b

BP is actively involved in the development of cellulosic ethanol and biobutanol and has funded multiple R&D and commercialization activities, including the $500 Energy Biosciences Institute. BP has formed partnerships with Verenium and DuPont and has invested in Mendel Biotechnologies, cellulosic startup Qteros, and microbial algae company Martek Biosciences.

Selected Headlines:

- In February 2009, BP and Verenium announced a 50/50 joint venture (Vercipia Biofuels) to develop a 36 million gallon-per-year commercial scale cellulosic ethanol facility in Highlands County, FL.
- In July 2009, BP pulled out of its partnership with British company D1 Oils to produce renewable fuels from jatropha in order to focus on biobutanol and cellulosic ethanol.

NYSE:BP | Jan 2008 - Dec 2009



CHEVRON

Chevron engages in fully integrated petroleum operations, chemicals operations, mining operations of coal and other minerals, power generation and energy services.

Segment: Conversion
Location: San Ramon, CA
Ownership: Public

Key Financial Metrics:

Revenue:	$444.6 b
Net Earnings:	$34.4 b
Net Margin:	7.7%
Market Cap:	$154.7 b

Chevron is proactively pursuing biofuels activities through its biofuels business unit as well as its venture arm, Chevron Technology Ventures. The company has made three biofuels equity investments and is involved in four research partnerships with government and academic institutions.

Selected Headlines:

- In January of 2008, Chevron Technology Ventures invested in Solazyme to test and develop its algae fermentation process to produce biodiesel.
- Chevron announced support for two biofuels players in September of 2009, the first an equity investment in LS9 and the second a feedstock sourcing and testing partnership with Mascoma.

NYSE:CVX | Jan 2008- Dec 2009

ROYAL DUTCH SHELL

Shell is the world's third largest non-state owned oil company. The company operates in five business segments: exploration and production, gas and power, oil sands, oil products, and chemicals.

Segment: Conversion
Location: The Hague, NL
Ownership: Public

Key Financial Metrics:

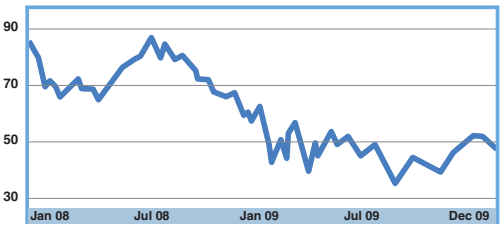
Revenue:	$736.5b
Net Earnings:	$39.2b
Net Margin:	5.3%
Market Cap:	$181.4b

The company has a global biofuels research program in universities in four countries and has made investments in biocatalyst company Codexis, biogasoline company Virent Energy Systems, algae fuel developer HR Biopetroleum, Canada's Iogen and Germany's Choren.

Selected Headlines:

- Shell made a second significant investment in technology development with Iogen Energy Corp in July of 2008 (its first was in 2002) and increased its stake in the company to 50 percent.
- In March of 2009, Shell made a second investment of $30 million in biocatalyst company Codexis in order to speed up its cellulosic biofuel commercialization efforts. It is estimated that Shell spent approximately $60 million on Codexis R&D in 2009.

NYSE:RDS | Jan 2008- Dec 2009



VALERO

Valero Energy Corporation is the largest independent oil refiner in the U.S. The company owns and operates 16 refineries in North America and the Carribbean to produce conventional gasolines, distillates, jet fuel, asphalt, petrochemicals, lubricants, and other products.

Segment: Conversion
Location: San Antonio, TX
Ownership: Public

Key Financial Metrics:

Revenue:	$181.3b
Net Earnings:	-$3.1b
Net Margin:	-1.7%
Market Cap:	$9.5 b

Valero is the third largest ethanol producer in the U.S. with an annual production capacity of nearly 800 million gallons per year. The company's seven plants four in Iowa, and one each in Minnesota, Nebraska and South Dakota - were all acquired from bankrupt VeraSun. The company also has one site under development in Indiana and an equity interest in four U.S. biofuel companies.

Selected Headlines:

- In April of 2009, Valero won in an auction seven of bankrupt ethanol producer VeraSun Energy's corn ethanol facilities. The plants were acquired along with one plant under development for $477 million.
- In November of 2008, Valero participated in a Series A financing for Solix, a Colorado-based open pond algae fuel company, one of five investments in biofuels the company made in 2008-2009.

NYSE:VLO | Jan 2008- Dec 2009

BATEMAN LITWIN

Segment: EPC
Locations:
U.S.: Williamsburg,VA
HQ: Amsterdam
Ownership: Public

Key Financial Metrics:

Revenue:	$1.6b
EBITDA:	-$73m
EBITDA Margin:	-4.6%
Market Cap:	$3.3b

Notes:
Income Data for two year period, July 2007 - June 2009, FY 2008/2009 data estimated

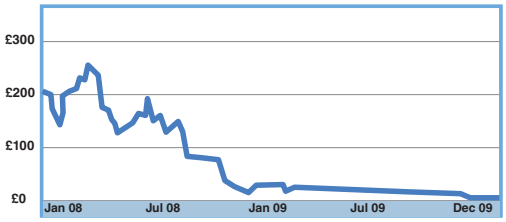
Delta-T is an engineering procurement and construction ("EPC") firm that has designed a large portion of the U.S. ethanol plants. The company has developed several technology advantages including low fresh water consumption, no process wastewater and high-efficiency drying systems. Delta-T also provides efficiency upgrades to existing corn ethanol plants.

Selected Headlines:

- 40 biofuel plants have been completed or are under construction by Delta-T. Of those unfinished are three plants for bankrupt ethanol producers Aventine and Pacific Ethanol.
- Bateman Litwin delisted from the AIM market in October of 2009 due to financial difficulties as a result of delays and cancellations of projects. Delta-T in particular has yet to contribute significantly to Bateman Litwin's bottom line.

Delta-T Corporation, a division of engineering firm Bateman Litwin, is a designer of high-tech bioethanol plants and refining systems that focus on low cost production, minimal environmental footprint and customized plant designs. Delta-T was acquired by Bateman Litwin in 2007. Bateman-Litwin's controlling shareholder, Bateman BV, is controlled by Beny Steinmetz's BSG group.

LSE:BNLN | Jan 2008- Dec 2009



Services

CH2M HILL

Segment: EPC
Location: Englewood, CO
Ownership Employee owned

Key Financial Metrics:

Revenue:	$11.1b
Net Earnings:	$170.3m
Net Margin:	1.5%

CH2M HILL provides engineering,procurement and construction ("EPC") services to a variety of energy projects, including bioenergy, solar, wind, hydro, and geothermal resources. The company has been an active player in the growth of the U.S. ethanol industry

Selected Headlines:

- CH2M Hill launched an energy unit at the start of 2008 to take advantage of oil, gas and alternative energy opportunities after investing $400 to acquire Veco Corp. and Trigon EPC in 2007.
- ZeaChem selected CH2M Hill as the EPC Contractor for its first cellulosic ethanol biorefinery in Boardman, OR. The project received a $25 million grant from the DOE in December of 2009.

Colorado's largest private company, CH2M HILL is a professional engineering services firm providing engineering, construction, operations, project management and related technical services. The company operates with offices worldwide covering most types of infrastructure and industry and an international portfolio of advanced renewable energy projects.

Services

FAGEN INC.

Fagen Inc. is the largest green economy design-build firm in the U.S. including in-house civil, structural, mechanical, and electrical engineering.The company is currently involved in the build out of the remaining corn ehtanol capacity in the U.S. and is mobilizing to address growth in advanced biofuels. The company is also engaged in a wide range of other infrastructure and process industries.

Segment: Design-Build
Location: Granite Falls, MN
Ownership: Private

Key Financial Metrics:
Revenue: $1.6 b

Fagen has built approximately two-thirds of the ethanol plants in the U.S. with a strategic focus on working with farmer-owned facilities. The company has the ability to take projects from conceptoin to operation. With the addition of Fagen Engineering, the company also provides civil, structural, mechanical, and electrical design. It is closely associated with ICM.

Selected Headlines:

- In May 2008 BBI International named Fagen as the preferred contractor for its cellulosic ethanol projects through its subsidiary BBI BioVentures LLC.
- In November of 2009, Southern Power selected Fagen as its EPC contractor for the Nacogdoches Generating Facility in Sacul, Texas. The facility is the largest single-boiler biomass project in the U.S.

Notes:
Income Data for one year period, Jan - Dec 2008

Services

ICM

ICM Inc. is an industry leader for the design, construction and support of ethanol plants. The company's process technologies support over a hundred plants - more than half the U.S. ethanol capacity today. The company has a close relationship with Fagen, Inc.

Segment: Conversion
Location: Colwich, KS
Ownership: Private

ICM is focused on sustaining agriculture through innovation and has contributed to the engineering advancements of today's corn ethanol dry mill process. The company is working with academia, government and private sector partners to develop cellulosic ethanol plant designs. It has contracts with a number of cellulosic ethanol and advanced biofuel companies including Coskata and Gevo.

Selected Headlines:

- ICM received $30 million from the DOE in February of 2008 to lead a multi-partner cellulosic ethanol project in St. Joseph, MO, with Novozymes, VeraSun Energy, Sun Ethanol and NREL, but subsequently withdrew from the project.
- ICM received another $25 million grant from the DOE in December of 2009 to modify an existing corn ethanol facility in St. Joseph, MO to produce cellulosic ethanol. ICM is co-locating the cellulosic biorefinery with an existing grain-to-ethanol pilot facility.

COBANK

CoBank is a $63 billion cooperative agricultural credit bankand part of the U.S. Farm Credit System, the oldest and largest single lender to U.S. agriculture and rural America. Agribusiness makes up about one quarter of the company's loan and lease portfolio, and approximately 4%of the company's agribusiness loans were for biofuels in 2008.

Segment: Venture Capital
Location: Greenwood Village, CO
Ownership: Partnership

08-09 Financial Metrics:*
Total Assets: $58.2b
Net Earnings: $1.1 b

CoBank is a major financial player in the ethanol industry and provides loans, leases and other financial services to farmer-owned ethanol businesses. The company has provided loans to ethanol facilities that represent approximately 20 percent of current and forecast industry capacity.

Selected Headlines:

- In September of 2008 the five System Banks of the Farm Credit System purchased $60 million in preferred stock of Farmer Mac, which provides a secondary market for agricultural real estate loans.
- The company's agribusiness lending declined substantially in 2009 due to the drop in prices for grains and farm inputs from 2008's high levels.

Notes:
Loans, Leases and Asset Data as of December 31, 2009

Finance

KHOSLA VENTURES

Khosla Ventures is a venture capital firm based in the Silicon Valley with a broad portfolio of clean energy technology companies. The firm is among the most active cleantech investors in the world, and approximately one third of the firm's portfolio is comprised of biofuels investments.

Current Biofuels Portfolio:

1. AltraBioFuels
2. Amyris Biotechnologies
3. Cilion
4. Coskata
5. Ethos
6. Gevo
7. Hawaii BioEnergy
8. KiOR Inc.
9. Lanza
10. LS9
11. Mascoma
12. Range Fuels
13. Verenium

Segment: Venture Capital
Location: Menlo Park, CA
Ownership: Partnership

Founder Vinod Khosla has taken an aggressive portfolio approach to early stage investing in biofuels, making his first investment in Celunol (now Verenium) in 1994 and at least 14 investments since 2003. The firm has been actively engaged in public policy and awareness campaigns to promote biofuels, specifically ethanol. Khosla Ventures has also built a broader clean energy portfolio including renewables, water, energy efficiency and materials.

Selected Headlines:

- In August of 2009 Khosla Ventures announced the closing of two new funds, a $250 million vehicle for seed-stage deals and a $750 million fund for larger follow-on investments. Both funds are largely funded by outside investors, including California Public Employees' Retirement System, the largest U.S. public pension fund. Until 2009 Khosla Ventures' investments were largely funded by Vinod Khosla himself.

LIST OF FIGURES AND TABLES

Operating Cash Flow Analysis, 2005 - 2009

Corn Ethanol Producers, Total Industry

ASSUMPTIONS	2005	2006	2007	2008	2009
Production (bgpy)	4.88	4.88	6.45	9	10.75
Major Cost Varaibles					
Ave Ethanol spot ($/gal)[1], *Source: OPIS*	1.72	2.56	2.02	2.22	1.69
Ave Corn Price ($/bu), *Source: CBOT*	2.09	2.69	3.78	5.27	3.74
Ave DDGS Price ($/ton)[2] ,*Source: USDA*	67	89	122	155	114
Ave Natural Gas Price ($/1000ft)[3] ,*Source: EIA*	7.32	6.40	6.39	9.58	5.09
Electricity ($/kWh)[4] *Source: EIA, OBP Estimates*	0.0375	0.0403	0.0416	0.0535	0.0652
Denaturant ($/gal) *Source: EIA, OBP Estimates*	0.1150	0.1346	0.1495	0.1495	0.1199
Cost Constants ($/gal), *Source: OBP Estimates*					
Other Chemicals Source:	0.0230				
Yeast and Enzymes	0.0408				
Water and Waste Mgmt	0.0108				
Maintenance	0.0400				
Labor and Overhead	0.1035				
Debt Service	0.1200				
Other Constants					
Conversion bu : gal	2.8				
DDGS ton : gal	308.7				
NG 1000ft3 : gal	31.25				

Notes

1. One month futures contract for denatured ethanol. See pricing discussion on pages 5-6 of 2007 Report for detail on inaccuracies of using spot price
2. USDA IL/IN Ethanol Plant Distillers Dried Grain DDGS 10% Moisture/USD Ton
3. The average price of natural gas sold to industrial consumers is used;
4. Weighted average industrial price of electricity.

CALCULATIONS *($ billion)*					
Industry TOTAL REVENUE	**$6.72**	**$12.44**	**$13.03**	**$19.98**	**$18.17**
Operating Costs					
Feedstock	2.91	4.67	8.71	16.94	14.36
DDGS credit	0.85	1.40	2.55	4.52	3.97
Net Feedstock	2.06	3.27	6.16	12.42	10.39
Fuels	0.914	0.995	1.319	2.759	1.751
Denaturant	0.449	0.654	0.964	1.346	1.289
Other Chemicals	0.159	0.198	0.263	0.367	0.439
Yeast and Enzymes	0.090	0.112	0.148	0.207	0.247
Electricity	0.146	0.198	0.268	0.482	0.701
Water and Waste Managemant	0.042	0.052	0.070	0.097	0.116
Maintenance	0.156	0.194	0.258	0.360	0.430
Labor and Overhead	0.404	0.503	0.668	0.932	1.113
Debt Service	0.468	0.583	0.774	01.080	1.260
Industry TOTAL COST	**$4.89**	**$6.76**	**$10.89**	**$20.19**	**$17.76**
Industry TOTAL CASH FLOW	**$1.83**	**$5.69**	**$2.14**	**($0.21)**	**$0.40**
Operating Cash Margin	27.2%	45.7 %	16.4 %	(1.0%)	2.2%

APPENDIX B: VENTURE CAPITAL RAISED

Selected Venture Capital Investments in U.S. Biofuels, 2008

Company	Description	Capital Raised	Date	Investors
BlueFire Ethanol	Public company in California licensing Arkenol Process Technology to convert cellulosic waste materials to ethanol	$15.5m	Jan-08	Quercus Trust
Coskata	Illinois-based company commercializing multi-feedstock syngas to ethanol conversion	$19.5m	Mar-08	Globespan Capital Partners, GM Corp., Capital Partners, Khosla Ventures, GreatPoint Ventures, Advanced Technology Ventures
Greenline Industries	Califronia-based producer of modular waterless wash biodiesel production platform applications	$20.0m	Mar-08	Leaf Clean Energy Company
Range Fuels	Founded by Vinod Khosla, the Colorado-based company was the first in the nation to break ground on a commerical-scale cellulosic biofuels facility	$166.2m	Apr-08	Khosla Ventures, Morgan Stanley, Pacific Corporate Group, Passport Capital, Blue Mountain Venture Capital, Leaf Clean Energy, unnamed energy company
Fulcrum BioEnergy	California municipal solid waste to ethanol converter	$14.0m	Apr-08	US Renewables Group, Rustic Canyon Partners
Greenfuel Technologies	Among the earliest algae fuels companies, formerly based in Massachusetts, the startup closed down in 2009	$13.9m	Apr-08	Access Private Equity, Draper Fisher Jurvetson, Polaris Venture Partners
OPX Biotechnologies	Colorado company focusing on engineering bacteria and fungi to digest organic materias into biofuels and bioplastics	$2.6m	Apr-08	Mohr Davidow Ventures, X/Seed Capital Management
Sapphire Energy	California-based company developing green crude from genetically engineered algae in an open-pond system	$50.0m	May-08	ARCH Venture Partners, Wellcome Trust, Venrock
Mascoma	New Hampshire cellulosic biofuels company focusing on consolidated bioprocessing technology	$61.0m	May-08	Khosla Ventures, Atlas Venture, Flagship Ventures, Kleiner Perkins Caufield & Byers, Pinnacle Ventures, GM, Marathon Oil, VantagePoint Venture Partners
Gevo	Colorado-based company planning to retrofit existing facilities to produce isobutanol for fuel	$17.0	May-08	Burrill & Co., Malaysian Life Sciences Capital Fund, Khosla Ventures, Virgin Green Fund, Total
EdeniQ	California Altra Biofuels spinoff developing yield enhancement technologies for cellulosic and corn ethanol producers	$33.1m	May-08	Advanced Equities Investments, Draper Fisher Jurvetson, Element Partners, Kleiner Perkins Caufield & Byers, Angeleno Group, Omninet, The Westly Group, Duff Ackerman & Goodrich, Northgate Capital
Aurora BioFuels	California-based company focusing on the production of bio-oil from algae using an open-pond system	$20.0m	Jun-08	Oak Investment Partners, Gabriel Venture Partners, Noventi
Raven Biofuels	New Jersey based cellulosic ethanol producer with a plant under development in India	$10.0m	Jul-08	Blackhawk Investments, Clean Energy Holding
Arisdyne Systems	Ohio-based spinout of Five Start Technologies licenses fuel cavitation technology from Cavitech to produce biofuels	$5.3m	Jul-08	Undisclosed
Amyris Technologies	California-based biotech firm and its Brazilian subsidiary are developing renewable diesel and semi-synthetic artemisinin	$90.0m	Aug-08	DAG Ventures, Khosla Ventures, Kleiner Perkins Caufield & Byers, TPG Biotech, individual investors
Solazyme	California company focusing on fermentation tank-based algae fuels production	$45.4m	Aug-08	Braemar Energy Ventures, Lightspeed Venture Partners, The Roda Group, Harris & Harris
Sapphire Energy	California-based company developing green crude from genetically engineered algae in an open-pond system	$50.0m	Sep-08	ARCH Venture Partners, Wellcome Trust, Venrock, Cascade Investment
Cobalt Biofuels	California-based developing non-food based biobutanol	$25.0m	Oct-08	Pinnacle Ventures, VantagePoint Venture Partners, Malaysian Life Sciences Capital Fund, @Ventures, LSP, Harris & Harris
Coskata	Illinois-based company commercializing multi-feedstock syngas to ethanol conversion	$40.0	Nov-08	Blackstone Cleantech Venture Partners, Sumitomo, Arancia, Khosla Ventures, Advanced Technology Ventures, Globespan Capital Partners, TriplePoint Capital
Solix	Colorado algae biofuels company focusing on photobioreactors and integrating CO2 delivery	$10.5m	Nov-08	I2BF Venture Capital, Bohemian Investments, Southern Ute Alternative Energy, Valero Energy, Infield Capital
Qteros *(formerly SunEthanol)*	Massachusetts cellulosic ethanol company with process based on the naturally occurring Q Microbe	$25.0m	Nov-08	Venrock, Battery Ventures, BP, Soros Fund Management, Long River Ventures, Camros Capital
BARD	Philadelphia-based company building a composite plant including biodiesel production, soy solvent extraction, and algae cultivation, harvesting and extraction	$40.0	Dec-08	Undisclosed
Petro Algae	Algae-based biofuel producer which raised capital through a reverse merger (non-private placlement)	$10.4m	Dec-08	Valens Capital Management (Reverse Merger)
Total Disclosed (23 deals)		**$784.4m**		

Sources: The Cleantech Group, Greentect Media, Company Sources

Selected Venture Capital Investments in U.S. Biofuels, 2009

Company	Description	Capital Raised	Date	Investors
Ze-gen	Massachusetts construction waste to syngas converter that plans to build plants near industrial customer facilities	$20.0m	Jan-09	Omaz Zawawi Establishment, Flagship Ventures, VantagePoint Venture Partners, Massachusetts Technology Development Corp
ZeaChem	Colorado-based company combinining biochemical and thermochemical cellulosic ethanol conversion techniques	$34.0m	Jan-09	Valero Energy, Globespan Partners, PrairieGold Venture Partners, Mohr Davidow Ventures, Firelake Capital
Codexis	California biocatalys developer with a strong relationship with Shell and Iogen to improve the cellulosic ethanol process	$30.0m	Mar-09	Royal Dutch Shell
OPX Biotechnologies	Colorado company focusing on engineering bacteria and fungi to digest organic materias into biofuels and bioplastics	$17.5m	Mar-09	Braemar Energy Ventures, Altira, Mohr Davidow Ventures, X/Seed Capital Management
Gevo	Colorado biofuel firm focused on developing butanol as an alternative fuel and chemical intermediates including polyacrylates and PETE	$ 40.0m	Apr-09	Total
Terrabon	Texas-based company employing fermentation technology to convert municipal solid waste to biocrude for renewable chemicals and gasoline	Undisclosed	Apr-09	Valero Energy
Glycos Biotechnologies	Texas-based company engineering microbial strains for the production of sustainable chemical intermediates, advanced ethanol and bioprocesses	$5.0m	Apr-09	Draper Fisher Jurvetson, DFJ Mercury
Qteros (formerly SunEthanol)	Massachusetts cellulosic ethanol company with process based on the naturally occurring Q Microbe	Undisclosed	May-09	Valero Energy (acquired VeraSun's stake in the company)
Solix	Colorado algae biofuels company focusing on photobioreactors and integrating CO2 delivery	$6.3m	Jun-09	Shanghai Alliance Investment Ltd.
Solazyme	California company focusing on fermentation tank-based algae fuels production	$11.6m	Jun-09	Braemar Energy Ventures, Lightspeed Venture Partners, VantagePoint Venture Partners, The Roda Group, Harris & Harris
Otoka Energy	Minnesota company converting CDS and wood waste into natural gas	$3.2m	Jun-09	Undisclosed
Joule Biotechnologies	Massachusetts-based synthetic biology company employing solar energy to converrt CO2 into liquid fuels and chemicals with non-algal organisms	Undisclosed	Jul-09	Flagship Ventures
LS9	California-based company focused on producing hydrocarbon fuels from genetically modified e.coli bacteria	$25.0m	Sep-09	CTTV Investments, Chevron Technology Ventures, Lightspeed Venture Partners, Flagship Ventures, Khosla Ventures
Biolight Harvesting	California company focused on a photosynthetic cyanobacteria-based production platform for making renewable fuels and chemicals	Undisclosed	Sep-09	CMEA
Amyris	California-based biotech firm and its Brazilian subsidiary are developing renewable diesel and semi-synthetic artemisinin	$41.8m	Oct-09	Grupo Cornelio Brennand, Naxos, Khosla Ventures, Kleiner Perkins Caufield & Byers, TPG Biotech, Votorantim Novos Negocios
Verdezyne	California company genetically engineering microbes to produce biofuels and biochemicals	$ 3.0m	Oct-09	Life Science Angels, Monitor Ventures, OVP Venture Partners, Tech Coast Angels
Solix Biofuels	Colorado algae biofuels company focusing on photobioreactors and integrating CO2 delivery	$3.0m	Nov-09	Bohemian Asset Management, i2BF Venture Capital, Southern Ute Alternative Energy, Valero Energy
Bio Architecture Lab	Washington synthetic biology and computational enzyme design company focusing on producing macroalgae-based butanol	$8.0m	Dec-09	Energy Capital Management, Statoil, Austral Capital, X/Seed Capital Management
Total Disclosed (18 deals)		**$248.4.4m**		

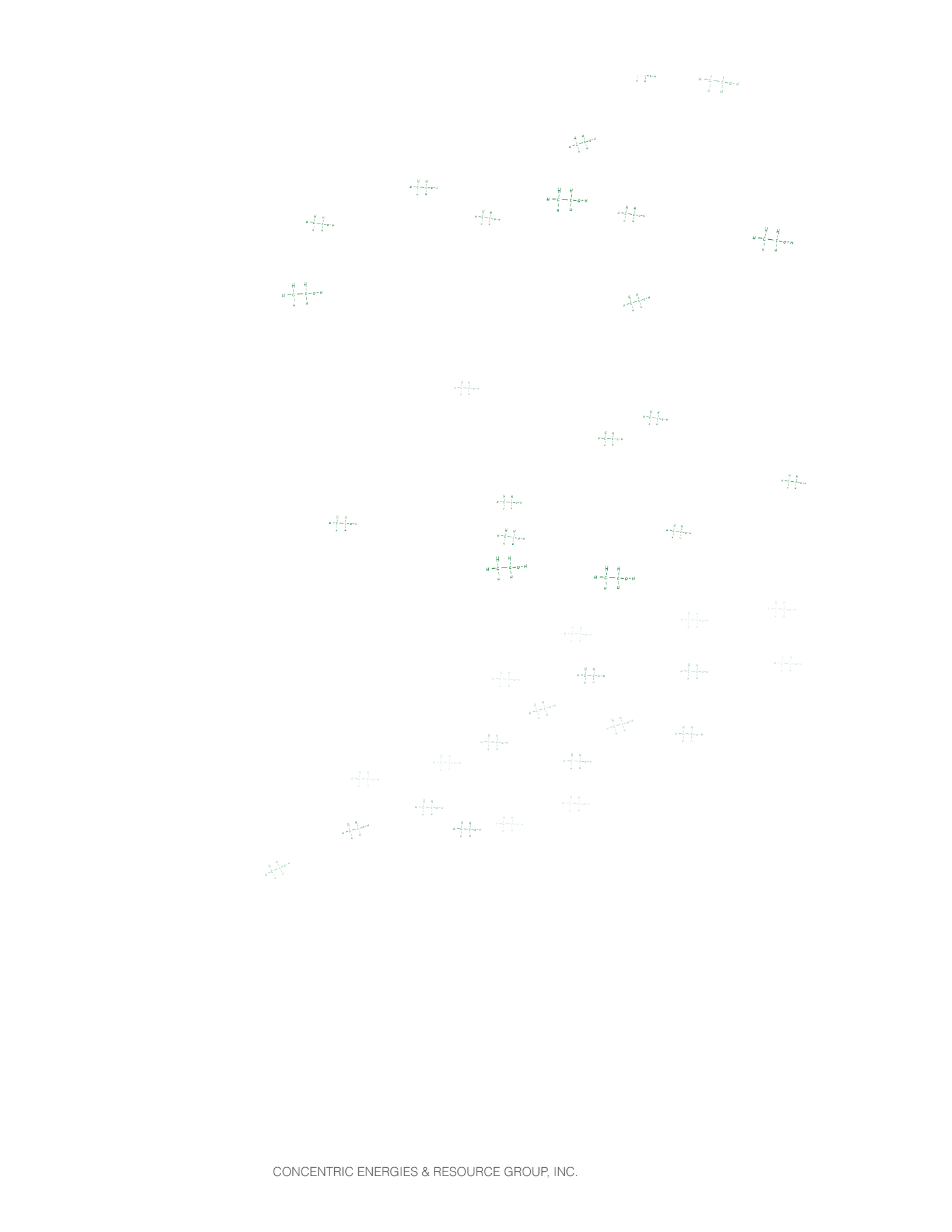
Sources: The Cleantech Group, Greentect Media, Company Sources

APPENDIX C: MAJOR OIL COMPANY INVESTMENTS

Major Oil Company Commercial Investment in U.S. Biofuels, 2005-2009

Oil Company	Partner	Fuel	Investment	Year	Details
Exxon-Mobil	Synthetic Genomics	algal fuels	**$600 million**	2009	R&D partnership, $300 million potentially paid to Synthetic Genomics
Royal Dutch Shell	Codexis	biocatalysts	**Undisclosed**	2006 & 2009	20% stake and multiple R&D investments to enhance biofuel enzymes
	Virent Energy Systems	hydrocarbon fuels	**Undisclosed**	2005 & 2008	R&D investments to commercialize thermochemical BioForming technology
	HR Biopetroleum	algal fuels	**Undisclosed**	2007	Majority stake in Cellana, a joint venture marine algae biofuel pilot plant
BP	Martek Biosciences	algal fuels	**$10 million**	2009	Partnership to study the use of algae to convert sugar into biodiesel
	Verenium	cellulosic ethanol	**$135 million**	2008 & 2009	Microbe joint venture (Vercipia) and commercial plant construction
	Qteros	cellulosic ethanol	**Undisclosed**	2008	Equity investment in microbe-based ethanol startup
	Mendel Biotechnology	biofeedstocks	**Undisclosed**	2007	Equity investment and five-year genomics R&D partnership
	Dupont	biobutanol	**Undisclosed**	2008	Agreement to commercialize biobutanol including Butamax joint venture
Chevron	LS9	hydrocarbon fuels	**Undisclosed**	2009	Chevron Technology Ventures investment for microbial UltraClean fuels
	Mascoma	cellulosic ethanol	**Undisclosed**	2009	Feedstock sourcing and product evaluation agreement
	Weyerhaeuser	cellulosic ethanol	**Undisclosed**	2008	Catchlight Energy, a wood-based cellulosic biofuel joint venture
	Solazyme	algal fuels	**Undisclosed**	2008	Chevron Technology Ventures R&D, feedstock and testing partnership
	Codexis	biocatalysts	**Undisclosed**	2006	5% equity stake in pharmaceutical and biofuel enzyme developer
	Galveston Bay Biodiesel	biodiesel	**Undisclosed**	2006	Chevron Technology Ventures 22% equity stake for commercial plant
ConocoPhillips	Tyson Foods	biodiesel	**Undisclosed**	2008	Program to commercialize biodiesel from Tyson's excess animal fat
	Archer Daniels Midland	hydrocarbon fuels	**Undisclosed**	2007	Alliance focused on biomass conversion and refining of biocrude
Valero	VeraSun	corn ethanol	**$737 million**	2009	Winning bid for 7 of VeraSun's corn ethanol plants in March, two in Dec.
	Renew Energy	corn ethanol	**$72 million**	2009	Purchase of one corn ethanol plant form bankrupt private producer in Dec.
	Terrabon	hydrocarbon fuels	**Undisclosed**	2009	Lead equity investment to convert municipal waste into renewable gasoline
	Qteros	cellulosic ethanol	**Undisclosed**	2009	Buyout of VeraSun's equity stake in microbe-based ethanol startup
	Zeachem	cellulosic ethanol	**Undisclosed**	2009	Equity investment in converting poplar tree biomass to ethanol
	Solix	algae fuel	**Undisclosed**	2008	Equity investment to build commercial-scale photobioreactor
Marathon	Mascoma	cellulosic ethanol	**$10 million**	2008	Equity investment for microbe development and plant construction
	The Andersons	corn ethanol	**Undisclosed**	2006	The Andersons Marathon Ethanol LLC joint venture plant
Total	Gevo	biobutanol	**Undisclosed**	2008	Equity investment to retrofit and construct plants
Sunoco	Northeast Biofuels	corn ethanol	**$8.5 million**	2009	Purchase of bankrupt largest production facility in the Northeast
Murphy Oil	VeraSun	corn ethanol	**$92 million**	2009	Purchase of former VeraSun plant from creditor AgStar

Sources: The Cleantech Group, Greentect Media, Company Sources



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