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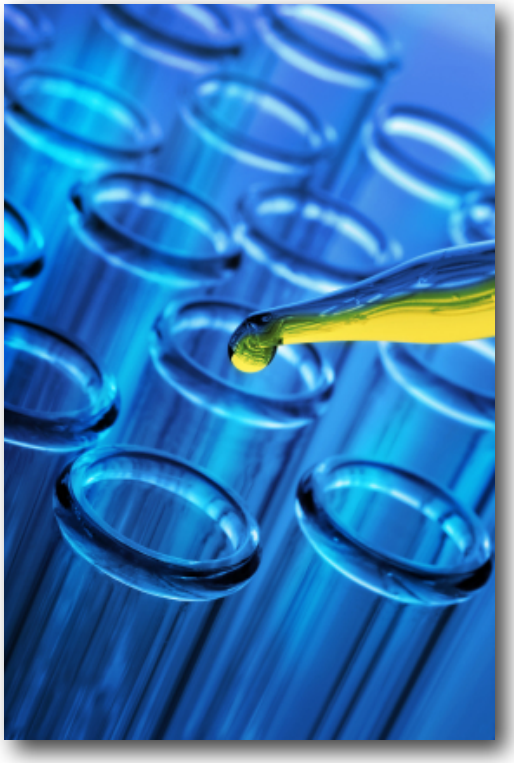

Advanced Biofuel Market Report 2011

Meeting the California LCFS

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Environmental Entrepreneurs (E2) is a non-partisan national community of 850 business people who believe in protecting the environment while building economic prosperity. Our mission is to provide a platform for an independent business voice to promote environmentally sustainable economic growth. E2 represents entrepreneurs, investors and professionals from every sector of the economy. We work at both the state and national levels through bipartisan efforts.

Introduction

Advanced biofuels are renewable transportation fuels that can replace traditional gasoline and diesel at a competitive price and with significantly lower greenhouse gas (GHG) emissions.[1] This report collects data from a variety of public sources and private interviews for the purpose of summarizing current economic activities in the advanced biofuel industry.

California enacted the Low Carbon Fuel Standard (LCFS) regulation in 2007 as part of the Global Warming Solutions Act of 2006 (known as AB 32). The LCFS requires that, by 2020, blenders, refineries, importers and distributors of transportation fuels reduce the "carbon intensity" (CI) of the fuels they sell by ten percent below a 2006 gasoline and diesel baseline. While the LCFS will be achieved with a variety of alternative fuels including electricity and natural gas, this report examines the ability to meet the reduction target only through the use of advanced biofuels in gasoline and diesel vehicles.

California uses approximately 18 billion gallons of transportation fuel per year.[2] E2's research shows that the vast majority of advanced biofuels are expected to possess just one quarter the CI of gasoline. For simplicity's sake, this report assumes that reduced travel and improvements in fuel efficiency will keep demand constant at 18 billion gallons per year through 2020. Therefore a ten percent reduction in carbon intensity could be met with a combination of 15.6 billion gallons of traditional fuel plus 2.4 billion gallons (gasoline equivalent) of advanced biofuels (assuming advanced biofuels' CI is one quarter that of gasoline and that traditional fuels' CI does not increase). To meet the earlier 2015 milestone of a 2.5 percent reduction, 600 million gallons (gasoline equivalent) of advanced biofuels are needed - although the 2015 target is more likely to be met with a combination of improved CI ethanol and advanced biofuels.

This report does not claim nor is it designed to prove that the private sector will produce 2.4 billion gallons (gasoline equivalent) of advanced biofuel for the California market. Rather it provides evidence that the combination of market forces and public policies has put the advanced biofuel technology and industry in the United States on a path where it should be able to produce a significant amount of low-carbon fuel in the next few years, thereby making it possible to deliver sufficient fuel to meet the California LCFS.

This report aggregates and analyzes the advanced biofuel industry's estimates of annual fuel production per year through 2015, as well as public and private investments in companies and production facilities. The report examines how different market factors and government policies influence investments, production, and distribution. Lastly, it describes various pathways through which fuel would be distributed into California to count towards the LCFS.

In summary, this report concludes that it is indeed possible to deliver enough advanced biofuel to meet the California LCFS. It finds that investment, not technology, is the biggest market barrier and that regulatory certainty is needed to ensure market stability. It also describes additional policies that California could pursue to improve the likelihood of meeting its LCFS goal.

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[1] US Environmental Protection Agency, "EPA Proposes New Regulations for the National Renewable Fuel Standard Program for 2010 and Beyond." Web. Retrieved 15 July 2011 from <http://www.epa.gov/oms/renewablefuels/420f09023.htm#2>.

[2] "Transportation Energy Statistics." California Energy Almanac. California Energy Commission. Web. 13 July 2011. <http://energyalmanac.ca.gov/transportation/summary.html>.

The Advanced Biofuel Industry

From start-ups to publicly traded companies, the advanced biofuel industry is experiencing significant activity and growth. Government regulations such as the Federal Renewable Fuel Standard (RFS2), the California LCFS, and the European Fuels Quality Directive,[3] in conjunction with rising oil prices and technological advances have improved investment opportunities over the last five years.

Under the RFS2, advanced biofuel or low-carbon fuel is defined as any fuel with a CI that is at least 50 percent lower than gasoline's.[2] While researching this report, E2 found that if a fuel lowers GHG emissions by 50 percent (or 48 g CO_2e/MJ) below the baseline of 96 g CO_2e/MJ, it typically goes significantly farther and reaches a carbon intensity of 24 g CO_2e/MJ or below.[4] This equates to a 75 percent reduction over gasoline produced from crude oil. Companies that are choosing to pursue low-carbon fuel pathways have discovered significant reductions through co-generation of renewable biomass not utilized for liquid fuel production, reusing or finding value-added commercial markets for byproducts, sourcing locally to reduce transportation impacts, and choosing non-food based feedstocks or byproducts residual to food production. Because of the significant CI reduction between these low-carbon fuel companies and their higher carbon counterparts, this report examines only the markets and industry forecasts for these low-carbon fuels estimated by E2 at 75 percent better than gasoline or diesel.

Active Companies

The advanced biofuel industry is a new, cleantech sector with many market entrants and players. As can be expected in an emerging industry, the number of advanced biofuel companies changes constantly. Consequently, very few, if any, comprehensive lists of active biofuel companies exist. The absence of such a database does not represent a lack of data or activity, merely the difficulty in tracking an ever-moving target. For this report, E2 has gathered information on currently active advanced biofuel companies. This snapshot of the current state of the industry gives us a baseline on which to gauge market projections and activity.

E2 identified 239 advanced biofuel companies in the United States and Canada. These companies are scattered across all stages of business development including venture capital backed start-ups, joint ventures and publicly traded companies. Some companies are only at the research and development stage, while many biodiesel facilities are already commercially producing fuel. Table 1 shows an overview of advanced biofuel producers and ancillary support businesses that provide feedstocks, infrastructure, distribution, catalytic processes, and more. These businesses are integral to providing the support and technology needed for advanced biofuels. Appendix A shows a complete listing of the active advanced biofuel companies, and Appendix C details supply chain affiliates identified by E2.

Active Advanced Biofuel Companies
2011

Fuel Type	Companies	Million Gal
Ethanol - Cellulosic	40	7.45
Biodiesel (Non-Soy)	160	350.00*
Diesel - Renewable	13	77.69
Gasoline - Renewable	7	0.13
Multiple Renewable (Gasoline, Diesel)	14	0.74
Other (Biobutanol, Biomethane, Syngas)	5	1.01
TOTAL	**239**	**437.03**

**Capacity much greater, at 2.1 billion gallons*

Supply Chain Companies		
Feedstock Producers	31	
Enzymes/Chemicals	16	
Related Tech	20	

***Table 1**: The 239 active advanced biofuel companies are already producing over 400 million gallons of low-carbon fuel in 2011.*

In the US and Canada alone, these companies are producing over 400 million gallons of low-carbon fuels in 2011 (Table 1). Non-soy biodiesel comprises the majority of this production, at approximately 350 million gallons.[5] Facilities producing biodiesel, the first advanced fuel in commercial production, have a significantly higher capacity and could produce as much as 2.1 billion gallons.[6] However, according to Shelby Neal of the National Biodiesel Board, total "biodiesel production will follow the RFS2 mandates pretty closely," demonstrating the impact of regulation on the industry's available markets. The RFS2 calls for 800 million gallons of biomass-based diesel in 2011, of which Louisiana-

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[3] RFS2: http://www.epa.gov/otaq/fuels/renewablefuels/index.htm
LCFS: http://www.arb.ca.gov/fuels/lcfs/lcfs.htm
European Fuels Quality Directive: http://ec.europa.eu/environment/air/transport/fuel.htm

[4] Carbon intensity values calculated by E2, based on publicly available information of each company's targeted fuel pathway and CI values or proposed CI values from California Air Resources Board.

[5] Wisner, Robert. Soybean Oil and Biodiesel Usage Projections and Balance Sheet, updated 18 Feb 2011. <http://www.extension.iastate.edu/agdm/crops/outlook/soybeanbalancesheet.pdf>. Values cited are for the "High" case.

[6] Neal, Shelby, National Biodiesel Board. Email correspondence with Mary Solecki 21 June 2011.

based Dynamic Fuel's renewable diesel is expected to provide 75 million gallons (MG), soy biodiesel 375 MG, and non-soy biodiesel 350 MG.

In contrast to the EPA's production numbers, E2 has counted production from pilot and demonstration facilities even though it is not actively traded in the fuel mix, and thus not tracked by EPA. Also, E2 has counted production from US-based Amyris for its Brazilian ethanol plant, as well as AE Biofuel's Keyes plant which is ahead of the EPA's latest production timeline. Beyond that, all other fuels are consistent with the production numbers available from the EPA for 2011 and 2012 (complete list in Appendix A).[7]

Abroad, at least 25 additional advanced biofuel companies have the potential to export to the US domestic market (Table 2). They are currently producing 791 million gallons of advanced fuel. Two of the largest companies, Neste Oil and Argent Energy, have registered facilities under the RFS2. This report identifies these foreign companies based upon significant levels of investment, development, and proximity to waterways or other distribution infrastructure. Detail of these companies may be found in Appendix B.

International Advanced Biofuel Companies
Possible California Imports

Fuel Type	# Companies	2011 MGPY	2015 MGPY
Ethanol - Cellulosic	10	5.87	75.32
Biodiesel (Non-Soy)	1	13.20	13.20
Diesel - Renewable	7	0.40	3.39
Gasoline - Renewable	0	0.00	0.00
Multiple Renewable (Gasoline, Diesel)	3	772.00	1,104.00
Other (Biobutanol, Biomethane, Syngas)	4	0.01	20.01
TOTAL	**25**	**791.48**	**1,215.92**

***Table 2**: MGPY = Millions of Gallons Per Year. International companies likely to export fuel to California are forecasting 1.2 billion gallons of fuel production in 2015, 1.1 billion of which is renewable drop-in fuels.*

2015 Fuel Capacity

To evaluate the market's capacity to meet the LCFS mandate by 2020, E2 used company-supplied forecast numbers for 2015 production. E2 discounted some production numbers, excluding producers that seemed unlikely to meet their targets. Information such as the company's funding status, planned construction, and annual fuel production targets were considered.

Given these considerations, the advanced biofuel industry is self-reporting capacity to produce **3.4 billion gallons of low-carbon fuel in the United States by 2015**. This is summarized in Table 3, and detailed in Appendix A. Adding international company projections brings the total to 4.6 billion gallons of fuel which could be used in California. As previously mentioned, 600 million gallons of fuel are needed to meet the LCFS in 2015 exclusively through advanced biofuels.

Industry Production Estimates (MGPY)

Fuel Type	2011	2015
Ethanol - Cellulosic	7.45	763.89
Biodiesel (Non-Soy)	350.00	575.00*
Diesel - Renewable	77.69	525.84
Gasoline - Renewable	0.13	157.83
Multiple Renewable (Gasoline, Diesel)	0.74	875.68
Other (Biobutanol, Biomethane, Syngas)	1.01	510.98
TOTAL	**437.03**	**3,409.22**

**Estimate based on RFS2 incremental increases*

***Table 3**: MGPY = Millions of Gallons Per Year. The biofuel market reports increased production of all advanced biofuels in the next four years.*

Of note is the increasing market share of renewable drop-in fuels[8] over time. Given their lower CI value, ease of integration into the existing infrastructure, and high energy content over ethanol, these fuels are of increasing interest to the fuel market and its investors. The total renewable drop-in fuel production (renewable diesel, renewable gasoline and multi-fuel renewable) will eclipse that of both biodiesel and cellulosic ethanol by 2015 at 1.5 billion gallons.

[7] United States Environmental Protection Agency. "Regulations of Fuels and Fuel Additives: 2012 Renewable Fuel Standards." Vol 76, No. 127. Web. Retrieved 19 July 2011. <http://www.gpo.gov/fdsys/pkg/FR-2011-07-01/pdf/2011-16018.pdf >

[8] Drop-in fuels may be processed through existing distribution infrastructure and combustion engines.

Financing

Significant investment has already been required to reach the current production of 400 million gallons. This investment trend must continue for the industry to expand commercial facilities. Investors and companies commonly refer to policies such as the LCFS and the federal RFS2 as factors that are increasingly pushing companies toward producing advanced biofuels with low CI values. Advanced biofuel companies access both private equity and public funding for financial support.

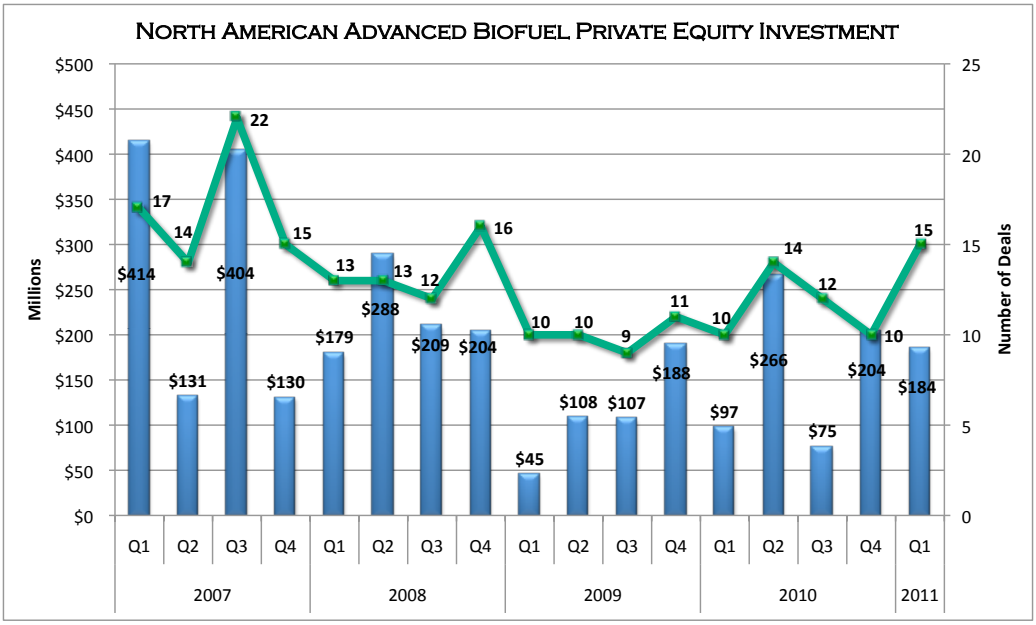

***Figure 1**: Venture capital investments in advanced biofuels by quarter; detailed in Appendix B.*

Private Equity Investment

The Cleantech Group forecasts the market of low-carbon fuels at $33.4 billion by 2020. This is nearly double the future market of energy efficiency ($17.3 billion), and significantly higher than renewable electricity ($20 billion).[9] To seize this opportunity, venture capitalists have invested at least $1.76 billion in active North American companies from 2007 through the first quarter of 2011, according to publicly available data (Appendix B). Figure 1 shows a quarterly overview of these investments.

Public Funding

Both the U.S. Department of Energy (DOE) and U.S. Department of Agriculture (USDA) have developed loan guarantee programs through which funding is lent to start-up companies and ventures. USDA has at least three active loan guarantees, and the DOE at least eighteen. The state of California also operates a renewable energy grant program, authorized by Assembly Bill 118 (AB 118).[10] The AB 118 program dedicates approximately $200 million annually to fund clean transportation projects through 2015. The California Energy Commission oversees up to $120 million of these grants, and has awarded funding to four California biofuel producers along with two additional supportive technology providers as of 2010. The American Recovery and Reinvestment Act (ARRA) provided an additional infusion of cash by matching funding of several AB 118 grantees.[11]

Grant, loans and funding sources are listed in Table 4. This data was compiled from company statements only, so it does not claim to be exhaustive.

Public Funding by Company

Company	Millions	State	Program
AE Biofuels	$1.88	CA	AB118 & ARRA
Algenol	$25	FL	DOE
Amyris	$24.3	CA	DOE
Bio Architecture Lab & DuPont	$18	CA DE	DOE
BlueFire Ethanol	$88	MS	DOE
Clear Fuels & Rentech	$22.6	CA	DOE
Cobalt Technology	$18	CA	DOE
Community Fuels	$2	CA	AB118
Coskata	$250	AL	USDA
Diamond Green (Valero & Darling)	$241	LA	DOE
Enerkem	$80	MS	USDA
Fulcrum Bioenergy	$80	NV	DOE
General Atomics	$2	CA	DOE
INEOS Bio & New Planet	$125	FL	DOE & USDA
Logos & EdeniQ	$20.5	CA	DOE
LS9	$9	CA	DOE
Mendota Advanced Bioenergy	$3	CA	AB118 & ARRA
OPX	$6	CO	DOE
POET	$105	IA	DOE
Sapphire Energy	$104.5	NM	DOE
Solazyme	$42.4	CA	DOE, AB118 & ARRA
SunPower Biodiesel	$0.8	WI	ARRA
Virent	$16.25	WI	DOE
ZeaChem	$25	OR	DOE

***Table 4**: Government grants & loans compiled from press statements.*

[9] Cheng, David, "California in Perspective: An Overview of State Energy Policies." Cleantech Group, 2010.

[10] http://www.energy.ca.gov/ab118/index.html

[11] "Alternative and Renewable Fuel & Vehicle Technology Program." California Energy Commission Home Page. State of California. Web. 07 July 2011. <http://www.energy.ca.gov/altfuels/index.html>.

Market Factors for Industry Growth

To determine how advanced biofuels can meet the California LCFS demand, E2 interviewed biofuel industry stakeholders ranging from venture capitalists and land-use experts to environmentalists and biofuel producers. While some perspectives on the current and future state of the biofuel industry differed, a number of commonalities emerged.

This report will discuss the key findings from these interviews according to four critical areas: feedstocks, funding, shift to commercial production, and regulatory landscape.

Venture capitalist Vinod Khosla best summarized many stakeholders concerns: "Technology is the not issue, it already exists - our concern is market commitment and feedstock."[12] The industry desires market commitment since it would yield financing. Hence the need for the State of California to pursue a robust LCFS program.

Biofuel Feedstocks

Advanced biofuel companies are moving forward with production based on conversion processes that enable use of multiple feedstock materials found in a wide variety of biomass sources, including fast-growing trees, grasses, municipal solid waste (MSW), algae and logging residue. The availability and cost of these feedstocks will also dictate the location of commercial facilities and the ability to scale. Among available feedstocks, cellulosic biomass represents significant commercial potential as a long-term feedstock source.[13]

With so many promising fuel pathways and companies, it is clear that the LCFS will not be met by a single fuel type, technology or feedstock, but through a combination thereof. Each feedstock category has numerous companies vested in the successful development and production of this critical input. Feedstocks being pursued by active advanced biofuel companies that could enter the California market include:

Cellulosic Biomass

Cellulosic biomass, including corn stover, woody biomass and waste is available in both tropical and temperate climates, has high yields, and does not compete with food.[14] For example, cellulosic biomass residue from agricultural and forest activities and micro-algal oil would be low-cost and result in minimal competition for land.[15] In the United States and California, woody biomass feedstock is seen as a viable option for volume production based on availability, cost, and yields. However, some in the environmental community have raised the concern that expanding the use of cellulose-based biomass, particularly woody biomass, could exert pressure on existing forest ecosystems and range land.[16] The most promising regions for woody biomass are likely to be private forest lands developed for the pulp and paper industry.

High-density biomass crops are being actively pursued by a number of companies, including CERES, Mendel, Chromatin and Yulex.

Low-Cost Sugars

Many companies are “feedstock agnostic,” only seeking low-cost, abundant sources of sugar. Since there may not be sufficient California-grown sugars, in-state facilities may be smaller, and will be co-located with any available feedstocks. Outside of California, the Southeastern United States will likely be a choice location for many facilities, with its abundant arable land and favorable climate.

For example, Virent currently operates a demonstration facility in Madison, Wisconsin using sugar beets from Cargill. Virent is testing and proving fuels with a variety of sugar sources, and could therefore change its ultimate commercial-scale feedstock and location based on price and availability.[17]

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[12] Khosla, Vinod. Principal, Khosla Ventures. Interview by Bob Epstein and David Richey, Environmental Entrepreneurs. 26 May 2011. Palo Alto.

[13] Timilsina, Govinda R., and Ashish Shrestha. “How much hope should we have for biofuels?” Energy (2010).

[14] McGee, Chandra, and Amy B. Chan Hilton. “Analysis of Federal and State Policies and Environmental Issues for Bioethanol Production Facilities.” Environmental Science & Technology (2011).

[15] Carriquiry, Miguel, Xiaodong Du, and Govinda R. Timilsina. “Second generation biofuels: Economics and policies.” Energy Policy (May 2011).

[16] Strittholt, James R and Tutak, Jocelyn “Assessing the Impact of Ecological and Administrative Considerations on Forest and Shrubland Biomass Projections for California.” Conservation Biology Institute. Web, 10 July 2011 <http://consbio.org/assessing-the-impact-of-ecological-considerations-on-forest-and-shrubland-biomass-projections-for-california/>.

[17] Rozmiarek, Robert and Blanchard, Mary. Virent Energy Systems. Phone Interview with Mary Solecki, 26 July 2011.

Algae and CO_2 Capture

Algae and CO_2 capture, among other areas of exploration, are potential sources of future fuels as active, well-funded companies are looking at scaling up technologies. An example of such a company is Joule Unlimited, which produces diesel through solar conversion of CO_2 capture. Joule has a target productivity rate of 15,000 gallons of diesel per acre, per year. (E2's 2015 projection of advanced biofuel production does not include any fuel from Joule, but the company could be a market entrant near that date.)

Algal biomass has a dedicated set of stakeholders investing in the development of algae as a feedstock. Companies like Sapphire and Kuehnle Agrosystems are focused on the economic and environmental gains from the commercial production of algae. Additionally, DARPA (Defense Advanced Research Project Agency) and the DOE have dedicated significant funding to the development of algae feedstocks through loan guarantees and research grants.

Latin American Sugarcane

Biofuels like sugarcane ethanol remain an option for the California market while the advanced biofuel industry is approaching commercial-scale production. As an average of 380 MGPY (Million Gallons Per Year) of sugarcane ethanol has already been imported from Brazil over the past five years to meet the RFS2, it is likely that Latin America will keep providing some portion of biofuel for the California market. If the RFS2 establishes an increased U.S. demand for 484-496 million gallons of other advanced biofuel in 2012, it could be economical for Brazilian producers to export higher volumes of sugarcane ethanol to the United States. The LCFS may also result in some refiners importing additional volumes of sugarcane ethanol from Brazil into California in 2012. These same volumes could count towards the RFS2 program as well.[18] Recently, federal legislation was introduced to lift the tariff on the import of South American ethanol, further increasing the ease of importing this fuel into the California market.

Funding

The advanced biofuel industry has received significant venture capital funding, as evidenced by the $1.76 billion of venture capital invested since 2007 mentioned earlier. This funding carries companies through research, development, and building pilot or demonstration facilities. However, to reach the next level of growth, companies need greater infusions of cash to build commercial-scale facilities. Most of that cash is expected to come from debt financing, which is typically difficult to obtain for the first few facilities due to the operational risk. Once those first few facilities are online, debt financing becomes much more feasible.

Revenue Generation through Biochemicals

To provide higher margin products with shorter paths to revenue, advanced biofuel companies are producing biochemicals and other high-value products in the short-term, allowing demonstration of functional product pathways and revenue growth. Companies such as Amyris and Solazyme are producing bio-oils as a biochemical replacement for the petroleum-based specialty chemical market.[19] This model of diversification provides the industry with multiple markets allowing companies to continue the development and scale-up of cost-efficient production.

As Jim Lane, editor of *Biofuels Digest*, stated in an interview with Cobalt Chief Executive Officer Rick Wilson:

> "If fuels incentives are just too tough for the country to afford, why not construct a mechanism by which advanced biorefineries can at least get a hand-up in getting into business as bio-based chemicals producers.
>
> That can in itself create the proof positive of performance that may well crack open the project finance market, and create the very expansion of fuel-producing capacity that the Renewable Fuel Standard expects and that the US, among many countries, both needs and can benefit from."[20]

This market bifurcation means that as more low-carbon fuels come to market, petroleum replacements will spread across all potential product categories, not just fuels.

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[18] Environmental Protection Agency, "Regulation of Fuels and Fuel Additives: 2012 Renewable Fuel Standards." Web, 10 July 2011. <http://www.epa.gov/otaq/fuels/renewablefuels/regulations.htm>.

[19] "Form S-1 Amyris Biotechnologies, Inc." U.S. Securities and Exchange Commission (Home Page). 16 April 2010. Web. 16 June 2011. <http://www.sec.gov/Archives/edgar/data/1365916/000119312510085595/ds1.htm>.

[20] "Why Make a $2 Fuel When You Can Make a $5 Chemical." Interview by Jim Lane. Biofuels Digest. 16 March 2011. Web. 08 July 2011. <http://biofuelsdigest.com/bdigest/2011/03/16/why-make-a-2-fuel-when-you-can-make-a-5-chemical-cobalt-ceo-rick-wilson/>.

Initial Public Offerings

Recently, four companies have gone public to raise cash needed to fund expansion plans. Renewable Energy Group has also recently announced an impending IPO. The successful recent IPOs have included:

- Amyris (California) - Raised $84.8 million in its IPO priced at $16 per share in September 2010.[21]
- Gevo (Colorado) - IPO raised $123.3 million, with the company selling 8.223 million shares at $15 per share in March 2011.[22]
- Solazyme (California) – May 2011 IPO priced at $18 a share netted $198 million.[23]
- KiOR (Texas) – June 2011, IPO raised $150 million selling 10 million shares at $15 per share.[24]

Looking at Solazyme, KiOR, Gevo and Amyris, clear commonalities emerge with respect to factors perceived as critical to achieving commercial market success:

- Solazyme is currently pursuing commercial scale-up in the fuels, chemicals and nutrition markets through partnerships whereby partner companies will invest capital and operational resources in building manufacturing capacity. The company has completed engineering designs for large commercial plants to service the fuels and chemical markets. The company's current Brazilian operations, California pilot plant, and Illinois demonstration fermentation facility will be augmented by a commercial facility in 2013 and additional commercial capacity in 2014 and 2015.[25]
- KiOR began construction of its initial-scale commercial production facility in Columbus, Mississippi in the first quarter of 2011. This is financed in part with a combination of existing cash on hand, equity commitments from existing investors and a $75 million interest-free loan from the Mississippi Development Authority. Critical to scaling success, all planned plants are located near feedstock sources, transportation infrastructure and pipelines.[26]
- Amyris currently operates a research and development laboratory in California and pilot facilities in Brazil. The company is expanding its production through a joint venture with the world's largest sugarcane processing facility. Amyris has also established non-binding letters of intent with three leading Brazilian sugar and ethanol producers to build new, bolt-on facilities for production.[27]
- Gevo's technology platform is based on modifying existing corn ethanol facilities to produce advanced biofuel. The company has demonstrated its production process via the retrofit of an ethanol facility in Missouri, and has acquired its first commercial facility in Luverne, Minnesota through direct acquisitions and joint ventures to produce more than 350 million gallons of advanced biofuel by 2015.[28]

[21] Lane, Jim. "Amyris Raises $84.8M in IPO, Prices at $16, Well below Expected Range." Biofuels Digest. 28 Sept. 2010. Web. 22 June 2011. <http://biofuelsdigest.com/bdigest/2010/09/28/amyris-raises-84-8m-in-ipo-prices-at-16-well-below-expected-range/>.

[22] Lane, Jim. "Gevo Raises $123.3 Million in IPO after Underwriters Oversubscribe." Biofuels Digest. 16 Mar. 2011. Web. 22 June 2011. <http://biofuelsdigest.com/bdigest/2011/03/16/gevo-raises-123-3-million-in-ipo-after-underwriters-oversubscribe/>.

[23] Lane, Jim. "Solazyme IPO Nets up to $227M." Biofuels Digest. 27 May 2011. Web. 22 June 2011. <http://biofuelsdigest.com/bdigest/2011/05/27/solazyme-ipo-nets-up-to-227m/>.

[24] Lane, Jim. "KiOR raises $150M in IPO, 30 percent below latest forecast." Biofuels Digest. 24 June 2011. Web. 27 June 2011. <http://biofuelsdigest.com/bdigest/2011/06/24/kior-raises-150m-in-ipo-30-percent-below-latest-forecast/>.

[25] "Form S-1 Solazyme, Inc." U.S. Securities and Exchange Commission (Home Page). 11 Mar. 2011. Web. 16 June 2011. <http://www.sec.gov/Archives/edgar/data/1311230/000119312511064209/ds1.htm>.

[26] "Form S-1 KiOR, Inc." U.S. Securities and Exchange Commission (Home Page). 11 Apr. 2011. Web. 16 June 2011. <http://www.sec.gov/Archives/edgar/data/1418862/000095012311034676/h80686sv1.htm>.

[27] "Form S-1 Amyris Biotechnologies, Inc." U.S. Securities and Exchange Commission (Home Page). 16 Apr. 2010. Web. 16 June 2011. <http://www.sec.gov/Archives/edgar/data/1365916/000119312510085595/ds1.htm>.

[28] "Form S-1 Gevo, Inc." U.S. Securities and Exchange Commission (Home Page). 12 Aug. 2010. Web. 16 June 2011. <http://www.sec.gov/Archives/edgar/data/1392380/000119312510187275/ds1.htm>.

Shift to Commercial Production

Each advanced biofuel company's initial public offering lays out a plan to scale production capacity. While few advanced biofuel companies currently operate large-scale facilities, the industry is shifting towards commercial scale production through these IPOs and other funding sources, with numerous companies expecting to complete facilities by 2015. According to E2's research, 29 advanced biofuel companies expect, by 2015, to complete commercial production facilities - each with a capacity in excess of ten million gallons per year, in addition to the 160 non-soy biodiesel facilities already in existence.

While construction of commercial production facilities does represent a significant cost, the marginal cost of production and capital costs are expected to decrease as the industry advances. Capital for commercial scale production facilities is becoming increasingly available as demonstrated by both public and private financial activity. As seen in the business plans of the publicly traded companies, costs are expected to be driven down by construction of facilities that can be readily replicated and co-located with sufficient and long-term sources of feedstocks. Additionally savings can be achieved with facilities that can be scaled and retrofitted from existing plants through bolt-on applications or simple modifications. Using woody biomass as a feedstock, KiOR stated in its S-1 filing an expectation of an unsubsidized production cost at below $1.80 per gallon of biofuel for its wood chips-to-biocrude technology.[29]

Despite being home to numerous advanced biofuel companies' headquarters, California faces some challenges as a center of commercial production. This is due to regulatory structure and feedstock limitations. As highlighted by a number of stakeholders, California's regulations and often lengthy approval process disincentivize companies from placing commercial production facilities within the state. Also the viability of commercial production facilities is dependent on long-term supplies of feedstock. While cellulosic biomass is readily available in California, the land where it can be sourced is primarily agricultural or public land, thereby increasing the challenge to providing long-term feedstock supplies.[30] Despite these hurdles, commercial production in California has potential due to the strong market demand for advanced biofuels and the consequent job creation potential. It may also benefit from strategies such as co-locating at paper and pulp facilities, streamlining regulations and approval processes, and clarifying municipal solid waste policy.[31]

To address the challenge of feedstock availability, California could consider a model similar to the USDA's Biomass Crop Assistance Program (BCAP).[32]

BCAP is a program which bridges the gap between growing biomass crops and constructing a large-scale biofuel facility. To help ease the time lapse while these two are simultaneously being established, BCAP assists with start-up costs and guarantees crop purchase. This program complements the requirements of the RFS2 by stimulating the development of new energy crops.

Regulatory Environment

Since fuel is a highly regulated market, government's role in spurring market development will help eliminate advanced biofuels' barriers to entry. Among industry stakeholders interviewed for this report, there is significant consensus that state and federal governments must help provide market certainty through the strong enforcement of regulations. Vantage Point partner Thomas Huot asserts "California can meet the 10% reduction with current market practices, but the state needs to recommit to driving the biofuel industry by keeping the goal and mandate robust."[33] Many industry stakeholders, especially producers, voiced concerns about the risk of ARB (California Air Resources Board) changing or lowering compliance targets, or granting waivers to non-compliant parties. This would weaken the overall effect of the LCFS by not giving investors the market signal needed to fund low-carbon fuel projects. As explained by the venture capital community, California can meet the LCFS reduction target with current market technologies and products,

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[29] Form S-1 KiOR, Inc." U.S. Securities and Exchange Commission (Home Page). 11 Apr. 2011. Web. 16 June 2011. <http://www.sec.gov/ Archives/edgar/data/1418862/000095012311034676/h80686sv1.htm>.

[30] White, Eric M. Woody Biomass for Bioenergy and Biofuels in the United States— A Briefing Paper. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station., 2010. http://www.fsl.orst.edu/lulcd/Publicationsalpha_files/White_pnw_gtr825.pdf.

[31] "E2 Biofuel Roundtable." Interview by Mary Solecki. Environmental Entrepreneurs 26 Jan. 2011. New York.

[32] http://www.fsa.usda.gov/FSA/webapp?area=home&subject=ener&topic=bcap

[33] Huot, Thomas. Parter, Vantage Point Venture Capital. Interview by Bob Epstein and David Richey, Environmental Entrepreneurs. 7 June 2011.

but government must ensure a strong mandate and a clear value for reduced CI.[34] Decreased regulatory certainty at the state-level results in companies not committing to the market. Conversely, providing long-term market commitment is likely to give companies the incentive to expand production to include both higher-margin biochemicals and biofuels.

To incite such a commitment, E2's interviews uncovered a number of recurring approaches: a credit trading market under the LCFS, off-take agreements in California, and price stability created through regulatory stability, all leading to willing market participation.

Credit Trading Market

Creating a transparent market under the California LCFS is predicated on a credit trading market. Matt Horton, CEO of Propel Fuels states that the industry "need[s] more certainty from ARB about what the compliance mechanism and trading scheme will be, in order to give a backbone to the credit market."[35] Investors and advanced biofuel producers must have an early price signal on the value of low-carbon fuels to guide investments and scale-up production. Such a price would attract "willing market participants" to enter the market in advance of the "obligated parties" (see below).

To create a market, it is essential that agencies – such as the California Air Resources Board (ARB) – utilize a mechanism that establishes a transparent carbon price, allows fuel providers to buy and sell credits in an open market, and allows for strong oversight by the regulatory entity. One mechanism that can achieve these goals is a formal trading exchange for LCFS credits. In contrast, an unregulated 'hands-off' approach to the market would require that oil companies and alternative fuel providers contact each other directly, which would result in many market inefficiencies.[36]

A credit trading mechanism must also provide a financial incentive to those regulated parties that over-comply, and a cost control mechanism for regulated parties struggling to meet the standard. For example, at Propel Fuels, an alternative fuel distributor, low-carbon E85 cannot yield a higher price than a higher-carbon equivalent. If the value of the credits were equal or higher than the extra cost of low-carbon ethanol, companies would have an incentive to switch.

Off-Take Agreements

Hawaii serves as a worthwhile case study in market creation through off-take agreements. In order to meet strong state mandates for renewable electricity (40 percent by 2030), Hawaiian Electric (HECO) issued a request for proposals (RFP) to supply up to 200 million gallons of sustainably produced, renewable biofuel per year to fuel power generation stations starting as early as July 2014. This resulted in ten proposals to create new, locally sourced biofuels (Hawaii produces nearly all of its electricity from liquid petroleum derivatives). HECO and the Hawaiian Public Utilities Commission are currently vetting proposals. Once approved, entrepreneurs can use this market guarantee to secure project financing, and to access needed resources to scale-up biofuel production.[37]

As a small island chain, Hawaii wants to reduce risk factors of its energy supply by producing fuels locally. As a result, all proposals have been tied to a landowner, assuring access to needed land. Stimulated by strong state policy, HECO is serving as a market creator with its unique off-take agreements, and therefore develops milestones for each project to ensure success. These milestones include proof of financing, start-up instruction, test quantities, land access, lifecycle assessments, and more. Similar off-take agreements could be implemented by California state agencies to spur additional market activity.

[34] "E2 Biofuel Roundtable." Interview by Mary Solecki. Environmental Entrepreneurs 26 Jan. 2011. New York.

[35] Horton, Matt. Propel Fuels CEO. Telephone interview by Bob Epstein and David Richey. 14 July 2011.

[36] Garderet, Remy. "Comments on the design of the LCFS credit market." Letter to Mary Nichols, 8 October 2009.

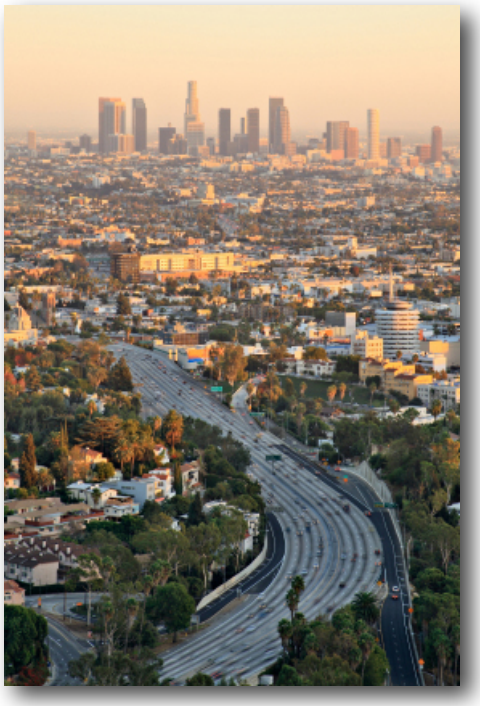
[37] Barnes, Cecily, Program Manager of Hawaiian Electric. Interview by Mary Solecki. 8 June 2011.

Price Stability

Price stability can be achieved in part through regulatory stability. ARB or the regulating entity must send clear signals to regulated parties that targets will not be postponed or reduced. As ARB's intentions to enforce the LCFS and non-compliance penalties remains steadfast, the value of biofuels will become dependable and worthy of additional investments.

Willing Market Participation

The advancement of policies to incentivize LCFS market participation will help ensure sufficient biofuel supplies to California. As highlighted by stakeholders, the state should develop a framework that enables "willing participants" to join the LCFS market rather than relying solely on "obligated parties" who participate only because of regulatory requirement. Both a credit trading market and off-take agreements would provide such willing participation. Today the LCFS mandates major fuel blenders, refineries, importers and distributors to reduce their CI. This current structure will result in a natural tendency to invest last and least given insufficient incentives and the higher risk to being early to the market. By contrast, a framework where third parties can identify early market opportunities and invest in the distribution of low-carbon fuels will incentivize them to join the market. As previously stated, a seller of E85 cannot charge extra for using a low CI ethanol. If instead, they can accumulate credits whose value is greater than the additional cost of using low carbon ethanol, they would have a natural business incentive to enter into agreements with advanced biofuel producers.



Meeting the LCFS - Scenarios for California

Today the advanced biofuel industry is actively pursuing the development and commercialization of a wide variety of possible advanced biofuels accessible to the California market. If ten percent of the 2015 potential market capacity of 3.4 billion gallons of advanced biofuel this report found was delivered to California, it could more than meet the market requirement of fuels to satisfy the CI reduction target.

As California approaches the 2020 deadline, numerous pathways exist to meet the LCFS. It will not be met by a single fuel type, technology or feedstock, but through a combination. Pathways available could include the following:

- A large portion of the demand is likely to be met by existing biofuel facilities with a reduced CI over gasoline's, although greater than advanced biofuels'.
- In the short-term, it can be expected that fuels such as grain-based ethanol and biodiesel could fill the LCFS market demand while advanced biofuel producers are shifting to full commercial production in the second half of the decade.
- Based on the market potential identified in this report, advanced "drop-in" biofuels could meet the majority of the LCFS mandate in the long-term.
- With biofuel production dependent on proximity to long-term sources of biomass, available advanced biofuels are likely to be produced outside of California.
- Sugarcane ethanol also remains an option for the California market while the advanced biofuel industry is still approaching commercial-scale production.
- As sugarcane ethanol is already produced at scale in countries such as Brazil, it is likely that Latin America could provide some portion of biofuel for the California market.
- While biofuels can be transported through standard shipping channels, infrastructure to off-load, store, and transport fuel will have to be repurposed or expanded. Advanced biofuels produced outside of the state will similarly require infrastructure for transport, storage, and distribution.

Conclusions

The report documents extensive economic activity surrounding advanced biofuels. This activity is illustrated by the significant venture capital investments over the last four years, the successful IPOs of four advanced biofuel producers, the transition from development to production of advanced biofuels represented by as many as 29 companies with new production facilities by 2015, and the number of total projects already underway.

This report leads to the following conclusions:

1. **Shift from technology to production risk** – The companies in this market have generally demonstrated that they have the technology needed to produce low-carbon fuels at volume. The market risks are concentrated on financing and scaling up production facilities and the availability of affordable biomass feedstocks.
2. **Bifurcation between high-value oils and fuels** – Companies such as Amyris and Solazyme have business models that benefit from short-term revenues producing high-value biochemicals and bio-oils while companies like Gevo and KiOR focus on transportation fuels. This market bifurcation means that even as more advanced biofuel companies come to market, resources will be spread replacing a variety of petroleum and oil products – not just fuels.
3. **Scaling will depend on availability of biomass** – Production facilities need to be co-located with sufficient, long-term sources of biomass. We will see smaller facilities located near sources of waste material that can be converted. Much of the industry is currently oriented towards woody biomass that can be sustainably harvested from private forests, and eventually derived from tree plantations.
4. **Fuels are likely to be produced outside of California** – As mentioned in (3), fuel production needs to be close to the source of biomass. Consequently, E2 expects most of the US fuel to be produced outside California given the low availability of local feedstock. Thus California needs to be an attractive market where the additional cost of transporting fuel is overcome by the economic value of a low CI.
5. **Drop-in fuels will be the main source of low-carbon biofuels** – Drop-in fuels are those that can operate in the same pipelines and facilities as petroleum-based fuels, e.g. renewable diesel and renewable gasoline. The 2015 production projections from companies show that the majority of volume will come from these fuels rather than 'specialty' fuels such as ethanol and biodiesel that require separate infrastructure. Thus while ethanol and biodiesel will fill the short-term demand, the second half of the decade will be dominated by advanced drop-in biofuels.
6. **Need to enable "willing participants" and not depend completely on "obligated parties"** – The LCFS defines major fuel blenders, refineries, importers and distributors as obligated to reduce their CI. However, they will naturally invest last, not first because there is higher risk in being early to market. By contrast, third parties can identify early market opportunities and invest in the distribution of low-carbon fuels. These "willing participants" need a mixture of market opportunities (see 7) and/or opportunities to accumulate credits (see 8) that they can sell at a later date.
7. **Off-take agreements can accelerate the early market** – As demonstrated in Hawaii by the HECO off-take agreements, firm contracts to purchase low-carbon fuel will draw business to the market. California government purchases should be considered as a way to start the early market.
8. **A transparent credit trading market is essential to developing biofuels** – A credit market creates a clear economic value for the reduced CI of a fuel. The credit market has been an important part of the development of RFS2, and the absence of the market is a barrier to developing the LCFS.
9. **The LCFS and RFS2 are stimulating investor interest** – Investments in advanced biofuels are heavily influenced by the economic value of low CI and by the demands for fuels to compete with, and displace, petroleum fuels that arise from the LCFS and RFS2. Any signals of weakening the programs would have a material effect on the industry.

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Appendix A: US and Canadian Advanced Biofuel Producers

Biodiesel at least 50% better than crude					
Company	State	Annual Production Capacity	Feedstock	Start Date	Website
Absolute Fuels	TX	50,000,000	Multi Feedstock	Q1 2010	www.absolutelubbock.com
Adirondack Biodiesel	NY	1,460,000	Waste Oils		
ADM	ND	85,000,000	Canola	Aug-07	www.adm.com
Agri-Source Fuels	FL	10,000,000	Multi Feedstock	Oct-07	www.asfuels.com
Agribiofuels	TX	12,000,000	Multi Feedstock	Dec-06	www.agribiofuels.com
Agrifuels	OH	1,000,000	Multi Feedstock	Mar-07	www.ohioagrifuel.com
Alternative Fuel Solutions	IN	800,000	Multi Feedstock	Jan-10	_
Alterra Bioenergy of Middle Georgia	GA	15,000,000	Multi Feedstock	Aug-07	www.alterrabioenergy.com
American Biodiesel Energy	PA	4,000,000	Multi Feedstock		www.americanbiodieselenergy.com
Baker Commodities	CA & MA	25,000,000	Multi Feedstock	Dec-10	www.bakerscommodities.com
BARD	PA		algae		www.bardllc.com
Batchelder Biodiesel Refineries	NH		Waste Oils		http://www.bbr-llc.com
Bay Biodiesel	CA	3,000,000	Multi Feedstock	Mar-07	www.baybiodiesel.com
Baystate Biofuels	MA		Waste Oils		www.baystatebiofuels.com
Beacon Energy	TX	12,000,000	Multi Feedstock	Mar-06	www.beacontx.com
Beaver Biodiesel	OR	940,000	Waste Oils		www.chemtools.com
Benefuel	IL		Waste Oils		http://www.benefuel.net/
Bently Biofuels	NV	1,000,000	Multi Feedstock	Nov-05	www.bentlybiofuels.com
Bio Alternative	IN	15,000,000	Waste Oils		http://www.bio-alternative.com
Bio Blend Fuels	WI	2,600,000	Multi Feedstock	May-09	www.bioblendfuels.com
Biodiesel Industries of Greater Dallas-Fort Worth	TX & CA	6,000,000	Multi Feedstock		www.biodieselindustries.com
Biodiesel of Las Vegas	NV	1,000,000	Multi Feedstock	4Q 2009	www.biodieseloflasvegas.com
Biodiesel of Pennsylvania	PA	1,500,000	Multi Feedstock	Mar-07	www.biodieselpa.com
Biodiesel of Texas	TX	2,000,000	Multi Feedstock	3Q 2009	www.biofuelsoftexas.com
BioDiesel One Ltd	CT	4,000,000	Multi Feedstock	Feb-09	http://biodieseloneltd.com/
Biofuels of Colorado	CO	15,000,000	Multi Feedstock		
BioPur	CT	1,000,000	Multi Feedstock	Jul-06	www.biopurinc.com
Blue Ridge Biofuels	NC	1,000,000	Multi Feedstock	May-06	www.blueridgebiofuels.com
Blue Sky Biofuels	CA	4,000,000	Waste Oils		www.blueskybio-fuels.com/
Blue Sun	CO		Waste Oils		www.gobluesun.com
Bluegrass Biodiesel	KY	9,000,000	Multi Feedstock	Jun-11	www.bluegrass-biodiesel.com
Buffalo Biodiesel Inc	NY		waste oils		www.buffalobiodiesel.com/
BullDog BioDiesel	GA	18,000,000	Multi Feedstock	Jan-08	www.bbiod.com
Cape Cod BioFuels	MA	500,000	Waste Oils	Sep-09	www.capecodbiofuels.com
Center Alternative Energy Company	OH	5,000,000	Multi Feedstock	May-07	www.centeroil.com
CGF Clayton	DE`	11,000,000	Multi Feedstock	Jan-10	www.cgfcorp.com
Chieftain BioFuels	OH	3,000,000	Multi Feedstock		
Clinton County Bioenergy	IA	10,000,000	Multi Feedstock	Aug-06	www.ccbebiodiesel.com
Community Fuels	CA	10,000,000	Multi Feedstock	Jun-08	www.communityfuels.com
Crimson Renewable Energy	CA	30,000,000	Multi Feedstock	3Q 2009	www.crimsonrenewable.com
CV Biofuels	CA		Waste Oils		http://www.cvbiofuels.com
Delta American Fuel, LLC	AR	40,000,000	Multi Feedstock	Mar-09	
Delta Biofuels, Inc.	MS	80,000,000	Multi Feedstock	May-07	www.deltabiofuels.com
Down to Earth Energy	GA	2,000,000	Multi Feedstock	Aug-09	www.downtoearthenergy.net

e-biofuels	IN	15,000,000	Multi Feedstock	Jun-07	www.e-biofuels.com
Eagle Biodiesel	AL & PA	33,000,000	Multi Feedstock		www.eaglebiodiesel.us
Earl Fisher Bio Fuels	MT	250,000	Multi Feedstock	Apr-08	www.earlfisherbiofuels.com
Eberle Biodiesel	TX	500,000	Multi Feedstock	Jan-11	www.eberlebio-diesel.com
Ecogy Biofuels	SC	30,000,000	Multi Feedstock	Dec-07	www.ecogybiofuels.com
Ecolife Biofuels	CA	1,500,000	Multi Feedstock	4/1/2010	www.ecolifebiofuels.com
Emergent Green Energy	KS	2,000,000	Multi Feedstock	Mar-09	www.egebio.com
Endicott Biofuels	TX	0	Multi Feedstock		www.endicottbiofuels.com
Energy Tec	IA	30,000	Waste Oils	Sep-08	
Environmental Development Group	AZ	1,500,000	Used Cooking Oil	Q2 2010	www.edgroup.us
Ever Cat Fuels	MN	3,000,000	Multi Feedstock	Oct-09	www.evercatfuels.com
Evergreen Biodiesel Production Facility	SC	36,000,000	Multi Feedstock	Jun-11	
Fina	OH	60,000,000	Multi Feedstock	Dec-06	www.fina-us.com
Foothills Bio-Energies	NC	5,000,000	Multi Feedstock	Sep-06	www.foothillsbio-energies.com
FUMPA BioFuels	MN	3,000,000	Multi Feedstock	Dec-04	www.biopup.com
Future fuel	AR	59,000,000	Multi Feedstock		www.futurefuelcorporation.com
Gen-X Energy Group	WA	15,000,000	Multi Feedstock	Jun-07	www.genxenergies.com
General Biodiesel	WA	10,000,000	Waste Oils	3Q 2009	http://generalbiodiesel.com
Genuine Bio-Fuel	FL	3,900,000		Jan-09	www.genuinebiofuel.com
Global Fuels	MO	3,000,000	Multi Feedstock	Apr-07	
Grecycle Arizona	AZ	2,500,000	Yellow Grease	May-09	www.grecycle.com
Green Earth Fuels of Houston	TX	90,000,000	Multi Feedstock	Jul-07	www.greenearthfuelsllc.com
Green Star Products		0	algae		http://www.greenstarusa.com
Green Valley Biofuels	SC	35,000,000	Multi Feedstock	3Q 2009	www.greenvalleybio.com
Greenleaf Biofuels	CT		Waste Oils		www.greenleafbiofuels.com
Greenwave Biodiesel	FL	4,000,000	Waste Oils	Aug-10	www.greenwavebiodiesel.com
Griffin Industries	KY	1,750,000	Multi Feedstock	Dec-98	www.griffinind.com
Heartland Bio Energy	FL	5,000,000	Multi Feedstock		www.heartlandbioenergy.us
Heartland Biofuel	IN	500,000	Multi Feedstock	Apr-06	
High Plains Bioenergy	OK	30,000,000	Multi Feedstock	Mar-08	www.highplainsbioenergy.com
Imperial Western Products	CA	10,500,000	Multi Feedstock	Oct-01	www.biotanefuels.com
Imperium Grays Harbor	WA	100,000,000	Multi Feedstock	Aug-07	www.imperiumrenewables.com
Inland Empire Oilseeds	WA	8,000,000	Canola	Nov-08	www.inlandempireoilseeds.com
Integrity Biofuels	IN	5,000,000	Multi Feedstock	Aug-06	www.integritybiofuels.com
Interstate Biofuels	NY		Waste Oils		www.interstatebiofuels.com
Iowa Renewable Energy	IA	30,000,000	Multi Feedstock	Jul-07	www.iowarenewableenergy.com
Jatrodiesel	OH	5,000,000	Multi Feedstock	Jun-07	www.jatrodiesel.com
Johnson Biofuels	FL	1,000,000	Waste Oil	Nov-09	www.johnsonbiofuels.com
Kansas Biofuels	KS	1,800,000	Multi Feedstock	Oct-07	www.kansasbiofuels.com
Keystone BioFuels	PA	60,000,000	Waste Oils	Mar-06	www.keystonebiofuels.com
Lake Erie Biofuels	PA	45,000,000	Multi	Sep-07	www.lakeeriebiofuels.com
Lantic Green Energy	RI	500,000	Waste Oils	4Q 2008	
Leland Organic Corporation	NC	30,000,000	Multi Feedstock	Sep-08	
Life Technologies	CA		Multi Feedstock		www.lifetechnologies.com/
Maine Standard Biofuel	ME	500,000	Yellow Grease	Jan-10	www.mainestandardbiofuel.com
Manning Beef	CA		Tallow	3Q 2009	
Mass Biofuel	MA				www.massbiofuel.com
MBP Bioenergy	MA	500,000	Waste Veg Oil	Jan-11	
ME Bioenergy	MO	5,000,000	Multi Feedstock	Jul-10	
Memphis Biofuels LLC	TN		Waste Oils		http://www.memphisbiofuels.com
Metro Fuel Oil Corp	NY			2009	www.metroenergy.com
Michigan Biodiesel	MI	17,000,000	Multi Feedstock	Jan-07	www.mibiodiesel.com
Midwest BioDiesel Producers	SD	7,000,000	Multi Feedstock	Mar-06	
Midwest Biodiesel Products	IL	30,000,000	Multi Feedstock	May-07	www.midwestbiodieselproducts.com
Natural Biodiesel Plant	MO	5,000,000	Multi Feedstock	Apr-07	
New Fuel Company	TX	250,000	Multi Feedstock	Apr-06	www.newfuelco.com
New Leaf Biofuel	CA	1,500,000	Used Cooking Oil	Dec-08	www.newleafbiofuel.com

Newport Biodiesel	RI	500,000	Used Cooking Oil	Jan-08	www.newportbiodiesel.com
NextDiesel	MI	20	Waste Oils		http://www.nextdiesel.net
NextFuels	CA		Multi Feedstock		www.nextfuels.com
Noil Energy Group	CA	5,000,000	Multi Feedstock	2Q 2009	
Northeast Biodiesel	MA		Waste Oils		www.northeastbiodiesel.com/
Northern Biodiesel	NY	20,000,000	Multi Feedstock	Jun-08	www.northernbiodiesel.com
Orbitek	OK		Multi Feedstock		http://www.orbitekinc.com/
Paquin Energy and Fuel	TX	5,000,000	Multi Feedstock		www.paquinenergyandfuel.com
Patriot Biodiesel	NC	1,500,000	Multi Feedstock	Dec-08	www.patriotbiodiesel.com
Pennslyvania Biodiesel	PA	25,000,000	Multi Feedstock	Jul-09	
Piedmont Biofuels	NC	4,000,000	Multi Feedstock	Nov-06	www.biofuels.coop
Pinnacle Biofuels	AR	10,000,000	Multi Feedstock	May-08	www.pinnaclebiofuels.com
Pleasant Valley Biofuels	ID	1,500,000	Used Cooking Oil	Aug-08	www.pvbiofuels.com
Promethean Biofuels Cooperative	CA	1,500,000	Multi Feedstock	9/5/2009	www.prometheanbiofuels.com
RBF Port Neches	TX	180,000,000	Multi Feedstock	4Q 2008	www.rbfuels.com
RECO Biodiesel	VA	10,000,000	Multi Feedstock	Dec-06	www.recobio.com
Red Birch Energy	VA	2,500,000	Multi Feedstock	Jun-08	www.redbirchenergy.com
REG	Many	272,000,000	Multi Feedstock		www.regfuel.com
Renewable Fuel Products	CA		Waste Oils		www.renewablefuelproducts.com/
REV Biodiesel	AZ	30,000,000	Multi-feedstock	Dec-10	www.revbiodiesel.com
Rio Valley Biofuels	NM	1,000,000	Multi Feedstock	Jul-06	www.riovalleybiofuels.com
San Francisco Public Utilities Commission	CA				www.sfwater.org
Sanimax Energy	WI	20,000,000	Multi Feedstock	Apr-07	www.sanimax.com
SBI Bioenergy	Alberta		Multi Feedstock		www.sbibioenergy.com
Scott Petroleum Corporation	MS	20,000,000	Multi Feedstock	Oct-07	www.scottpetroleuminc.com
Seminole Biodiesel	GA	10,000,000	Multi Feedstock	Jan-08	www.inland-stores.com
Sequential	OR	17,000,000	Waste Oils		www.sqbiofuels.com
Shenandoah Agricultural Products	VA	300,000	Used Cooking Oil	3/15/2010	
Simple Fuels Biodiesel	CA	1,000,000	Waste Oils	3Q 2009	www.simplefuels.com
Simply Green Biofuels	NH				www.seacoastbiofuels.com
Smart Fuels Florida	FL			3Q 2009	http://www.smartfuelsllc.com/
South East Oklahoma Biodiesel	OK	5,000,000	Multi Feedstock	Nov-08	
Southern Alliance for Clean Energy	TN	380,000	Used Cooking Oil	Jul-09	www.cleanenergy.org
Soymor	MN	30,000,000	Vegetable Oils	Aug-05	www.soymor.com
Stepan Company	IL	22,000,000	Multi Feedstock	Jan-01	www.stepan.com
Sullens Biodiesel	TN	2,000,000	Waste Veg Oil	Nov-09	
Sun Power Biodiesel	WI	3,000,000	sunflower, canola	Dec-09	http://www.growsunpower.com/
Synergy Biofuels	VA	3,000,000	Multi Feedstock	Dec-08	www.synergybiofuels.com
Terra Bioenergy	MO	30,000,000	Multi Feedstock	4Q 2009	
Texas Biotech	TX				www.txbiotech.com
Texas Green Manufacturing	TX	1,250,000	Tallow	Apr-09	www.texasgreen.biz
The La Grange Plant	TX	3,500,000	Multi Feedstock	Oct-10	www.thelagrangeplantinc.com
Thumb BioEnergy	MI				www.thumbbioenergy.com
TMT Biofuels	NY	250,000	Used Cooking Oil	Sep-08	
TPA Inc.	MI	20,000,000	Multi Feedstock	Jul-08	www.thepoweralternative.com
Tri-State Biodiesel			Waste Oils		www.tristatebiodiesel.com
Triangle Biofuels Industries	NC	3,000,000	Multi Feedstock	Jan-08	www.trianglebiofuels.com
United Oil Company	PA	5,000,000	Multi Feedstock	Dec-05	www.unitedb100.com
US Alternative Fuels Corp.	PA			4Q 2008	
Valley Biodiesel	CA				
Vanguard Synfuels	LA	12,000,000	Multi Feedstock	Apr-06	
Virginia Biodiesel Refinery	VA	7,000,000	Multi Feedstock	Oct-03	www.virginiabiodiesel.com
Walsh Bio Fuels	WI	5,000,000	Multi Feedstock	May-07	
Washakie Renewable Energy	UT	10,000,000	Multi Feedstock	Jan-09	www.wrebiofuels.com

Western Dubuque Biodiesel	IA	36,000,000	Crude or Refined Vegetable Oils	Aug-07	www.wdbiodiesel.net
Western Iowa Energy	IA	30,000,000	Multi Feedstock	Jun-06	www.westerniowaenergy.com
White Mountain Biodiesel	NH	5,500,000	Multi Feedstocks	Jun-10	www.whitemountainbiodiesel.com
Whole Energy Fuels	WA & CA	10,500,000	Used Cooking Oil	1Q 2009	www.whole-energy.com
Yokayo Biofuels	CA	500,000	Used Cooking Oil	Apr-06	www.ybiofuels.org
160 Biodiesel Companies	Capacity* (GPY):	2,189,460,020			

* Actual production of biodiesel closely follows that of the RFS2 requirements, despite the availability of higher capacity.
List provided by National Biodiesel Board.

Advanced Biofuels at least 50% Better than Crude									
Company	State	Fuel Type	Production in 2011 MGPY	Anticipated 2012 Production Capacity MGPY	Anticipated 2015 Production Capacity MGPY	Feedstock	Private Investment (Millions 2007-Q1 2011)	LCFS/ RFS2 Registered	Website
American Energy Independence	NH	Diesel-Renewable				biomass		RFS2	www.amenico.com
Amyris	CA	Diesel-Renewable	2.51	17.01	44.01	sugar	$215.95		www.amyrisbiotech.com
Diamond Green	LA	Diesel-Renewable	0	0	137	animal waste			valero.com
Dynamic Fuels	LA	Diesel-Renewable	75	75	75	animal waste		RFS2	www.dynamicfuelsllc.com
Flambeau River Biofuels	WI	Diesel-Renewable	0	0	6	woodwaste			www.flambeauriverpapers.com
Kent Bioenergy	CA	Diesel-Renewable	0.01	0.01	0.01	algae			www.kentbioenergy.com
LS9	CA	Diesel-Renewable	0	0.05	0.1	biomass			www.ls9.com
ORYXE Energy	CA	Diesel-Renewable							www.oryxe-energy.com
REII	CA	Diesel-Renewable	0.02	0.35	0.35	Multi-feedstock			www.reiinternational.com
Rentech	CA	Diesel-Renewable	0.15	0.15	259	Multi-feedstock			www.rentechinc.com
SG Biofuels	CA	Diesel-Renewable				Jatropha			www.sgbiofuels.com
TerViva	CA	Diesel-Renewable	0	0	0.5	Seed Oil			www.terviva.com
Trenton Fuel Works	NJ	Diesel-Renewable	0	0	3.87	mixed cellu-lose		RFS2	www.trentonfuelworks.com
Abengoa	MO	Ethanol	0.01	0.01	15	cellulose		LCFS/RFS2	www.abengoabioenergy.com
AE Biofuels	CA	Ethanol	0.05	10.04	10.05	cellulose			www.aebiofuels.com
Algenol	FL	Ethanol	0.1	0.1	100.1	algae			www.algenolbiofuels.com
Altra Biofuels	CA	Ethanol				cellulose		RFS2	www.altrabiofuels.com
American Process	GA	Ethanol	0	0.47	0.47	cellulose			www.apiweb.com
Archer Daniels Midland	IL	Ethanol	0	1	1	stover			www.adm.com
BlueFire Ethanol	CA	Ethanol	3.9	3.9	22.9	woody bio-mass	$10		http://bluefireethanol.com/
BP (Verenium)	CA	Ethanol	1.4	1.4	37.4	bagasse			www.bp.com
Bunge	MO	Ethanol				sugarcane		RFS2	http://bunge.com
Calgren	CA	Ethanol	0	0	58	corn		RFS2	www.calgren.com
Catchlight Energy	CA	Ethanol				woody bio-mass			www.catchlightenergy.com
Citrus Energy	FL	Ethanol				cellulose			www.citrusenergy.net
Coskata	IL	Ethanol	0.05	0.05	55.05	multi-feedstock	$93.2		www.coskata.com
DDCE	TN	Ethanol	0.15	0.25	50.25	stover			www.ddce.com

EdeniQ	CA	Ethanol				corn			www.edeniq.com
Enerkem	Que-bec	Ethanol	0.3	0.3	21.3	MSW	$123.58		www.enerkem.com
Fiberight	IA	Ethanol	0.01	3	6	MSW		RFS2	www.fiberight.com
Fulcrum Bioenergy	CA	Ethanol	0.01	0.51	42	MSW	$95		www.fulcrum-bioenergy.com
Garden State Ethanol	NJ	Ethanol				algae			
Genahol	OH	Ethanol	0	0	18	MSW			www.genahol.com
Gulf Alternative Energy	TX	Ethanol				cellulose			www.gulfalternativeenergy.com
Helios	PA	Ethanol	0.03	0.03	0.03	cellulose			
INEOS Bio	IL	Ethanol	0	3	8	MSW			www.ineosbio.com
Iogen	On-tario	Ethanol	0	0	1	cellulose			www.iogen.ca
KL Energy Corp	WY	Ethanol	1	1	1.3	wood waste	$4		www.klenergycorp.com
Lignol Biofuel	BC	Ethanol	0.02	0.02	0.02	woodwaste			www.lignol.ca
Logos Technologies	VA	Ethanol	0	0.8	0.8	cellulose/ MSW			www.logostech.net
Masada	AL	Ethanol				MSW			www.masadaonline.com
Mascoma	NH	Ethanol	0.4	0.4	40.2	wood chips	$131		www.mascoma.com
Mendota Advanced Bioenergy	CA	Ethanol				Beet waste			
Novogy	MA	Ethanol				Pulp waste	$0.75		www.novogyinc.com
POET	SD	Ethanol	0	0	25			LCFS/RFS2	www.poet.com
Powers Energy	IN	Ethanol				MSW			www.powersenergyofamerica.com
Purevision Technology	CO	Ethanol				Multi-feedstock			www.purevisiontechnology.com
Qteros	MA	Ethanol				Multi-feedstock			www.qteros.com
Syntec Biofuel	BC	Ethanol				waste/mixed cellulose			www.syntecbiofuel.com
US Envirofuels	FL	Ethanol				sorghum/ sugarcane			www.usenvirofuels.com
Verdezyne	CA	Ethanol				sugars			www.verdezyne.com
Woodland Biofuels	On-tario	Ethanol	0.02	0.02	0.02	wood waste	$5.2		www.woodlandbiofuels.com
Zeachem	OR	Ethanol	0	0.25	250	mixed cellu-lose			www.zeachem.com
Cool Planet Biofuels	CA	Gasoline - Renewable				biomass	$34.5		www.coolplanetbiofuels.com
CORE Biofuel	BC	Gasoline - Renewable	0	4.4	17.8	woodwaste			www.corebiofuel.com
Joule Biotechnologies	MA	Gasoline - Renewable	0.01	0.01	0.01	CO2	$30		www.jouleunlimited.com
Murphy Oil	AR	Gasoline - Renewable	0	0	115	animal waste		RFS2	www.murphyoilcorp.com
Primus Green Energy	NJ	Gasoline - Renewable	0.02	0.02	0.02	cellulose			www.hclcleantech.com
Terrabon	TX	Gasoline - Renewable	0.1	1	25	MSW	$1.25		www.terrabon.com
Zeropoint	NY	Gasoline - Renewable				woodwaste	$3.12		www.zeropointcleantech.com
Gevo Develop-ment	CO	Other - Isobutanol	1	10	350	multiple feedstocks	$66.1		www.gevo.com
Butamax	DE	Other- Biobutanol	0	0.5	160.5	corn			www.butamax.com
Cobalt Technology	CA	Other- Biobutanol	0.01	0.48	0.48	corn	$50.5		www.cobaltbiofuels.com
BioFuels Energy	CA	Other-Biomethane				MSW		RFS2	www.biofuelsenergyllc.com

EcoTech Fuels	CA	Other-Synfuel				MSW			www.ecotechfuels.com
Aquatic Energy	LA	Multi Renew	0.03	0.03	0.03	algae			www.aquaticenergy.com
Bio Architecture Lab	CA	Multi Renew				algae			www.ba-lab.com
Blue Fuel Energy Corporation	BC	Multi Renew	0	0	61.32	CO2			www.bluefuelenergy.com
ClearFuels	HI	Multi Renew	0.07	0.07	38.07	woodwaste	$3.5		www.clearfuels.com
Diversified Energy	AZ	Multi Renew				Multi-feedstock			www.diversified-energy.com
General Atomics	CA	Multi Renew				algae			www.gat.com
Green Pacific Biologicals	CA	Multi Renew				algae	$0.23		www.greenpacificbio.com
KiOR	TX	Multi Renew	0.23	6.7	250.23	woody bio-mass	$111.47		www.kior.com
Sapphire Energy	CA	Multi Renew	0.02	0.02	1.02	algae	$101.4		www.sapphireenergy.com
SCIPIO Biofuels	CA	Multi Renew	0	0	320	algae			www.scipiobiofuels.com
Solazyme	CA	Multi Renew	0.38	0.75	145	Multi-feedstock	$350		www.solazyme.com
Sundrop Fuels	CO	Multi Renew	0	0	40	Multi-feedstock			www.sundropfuels.com
SynGest	CA	Multi Renew				mixed cellu-lose			www.syngest.com
Virent	WI	Multi Renew	0.01	0.01	20.01	mixed cellu-lose	$67.4		www.virent.com
79 Companies		**Total (MGPY):**	**87.02**	**181.11**	**2,834.22**		**$1,271.04**		

Production capacity was left blank for companies without data available to E2.

Appendix B: International Advanced Biofuel Companies Likely to Enter the California Market

Company	Country	Fuel Type	Production in 2011 MGPY	Anticipated 2015 Production MGPY	Feedstock	Private Investment (Millions of Dollars)	LCFS/ RFS2 Registered	Website
Argent Energy	UK	Biodiesel	13.2	13.2	waste oil		RFS2	www.argentenergy.com
Australian Renewable Fuels	Australia	Diesel-Renewable			used cooking oil			www.arfuels.com.au
Bionersis SA	France	Other – Biogas				$20.40		www.bionersis.com
Biotor Industries	India	Biodiesel			Castor Oil	$38.5		www.biotorindustries.com
Borregaard	Norway	Ethanol	0.11	0.11	Mixed cellulosic residue			
Brazilian Renewable Energy Company	Brazil	Ethanol - Sugarcane	0.8	0.8	sugarcane			www.eth.com
COFCO/Sinopec	China	Ethanol	3	3	corn stover			
Ensyn Corporation	Malaysia	RDIF	0	316	pal waste	$3		http://www.ensyn.com/
Green Gas International BV	UK	Other – Biogas				$20.86		
Gushan Environmental Energy	China	Diesel-Renewable				$25		www.chinagushan.com/en/
Hebei Zhenghe	China	Diesel-Renewable				$2		
Inbicon	Denmark	Ethanol	1.4	19.4	Straw			
Kumho Petrochemical	Korea	Biodiesel	0.39	0.39	algae			www.kkpc.co.kr
Lanza Tech	China	Ethanol	0.5	40	Steel gas waste			www.lanzatech.co.nz
MBD Energy	Australia	Diesel-Renewable	0.01	3	algae			www.mbdenergy.com
Naturally Scientific	China	Other – Bio-oil	0.01	20.01	CO2			
Neste Oil	Finland	Diesel-Renewable	772	772	palm, rapeseed oil, waste fat		RFS2	www.nesteoil.com
Petrobras	Brazil	Ethanol	0	4	bagasse			www.petrobras.com
Praj Industries	India	Ethanol				$29.3		www.praj.net
Qantas/Solena	Australia	RDIF	0	16				http://www.solenafuels.com/
Santelisa Vale SA	Brazil	Ethanol				$212		
SBAE Industries	Belgium	Diesel-Renewable				$1.2		www.sbae-industries.com
Seaweed Energy Solutions	Norway	Other – Biogas						www.seaweedenergysolutions.com
TMO Renewables	UK	Ethanol	0.01	0.01	cellulose	$58.1		www.tmo-group.com
Weyland / Statoil Hydro	Norway	Ethanol	0.05	8	mixed cellulose			http://weyland.no
25 Companies		**Total MGPY:**	**791.48**	**1,215.92**		**$410.36**		

Appendix C: Related Businesses

Feedstock/Biomass Producers					
Company	State	Production in 2011 MGPY	Anticipated Production 2015 MGPY	Private Investment (Millions of $)	Website
AgRefresh	VT				www.agrefresh.org
Alchemix Corporation	AZ				www.alchemix.net
AlgaeVenture Systems	OH			$1.5	www.algaevs.com
ArborGen	SC				www.arborgen.com
Aurora Algae	CA	0.03	.52	$48.41	www.auroraalgae.com
BEST Energies	WI				www.bestenergies.com
Bio-fuels Inc	FL				http://bio-fuelsusa.com/
BioMCN	Netherlands			$46	www.biomcn.eu
Ceres Biofuels	CA				www.ceres.net
Chip Energy	IL				www.chipenergy.com
Chromatin	IL				www.chromatininc.com
Community Biofuels	CA				www.communitybiofuels.com
Florida Crystals Corp	FL				www.floridacrystals.com
Genomatica	CA				www.genomatica.com
Green Pacific Energy Ltd.	Australia			$2	
Imperative Energy Ltd	Ireland			$42.5	www.imperativeenergy.ie
Kuehnle AgroSystems	HI				www.hawaiibioenergy.com
Maine Bioproducts	ME				www.mainebioproducts.com
Mendel Biotechnology	CA				www.mendelbio.com
Nova Fuels	CA				www.novafuels.com
Petro Algae	FL	.12	110.12	$10	www.petroalgae.com
Power Stock	WA				www.pacificpowerstock.com
Renewed World Energies	SC				www.rwenergies.com
Renmatix (Sriya Innovations)	GA			$15	renmatix.com
Shalivahana Projects Ltd	India			$48.75	http://shalivahanaprojects.com
SmartSoil-Energie Inc.	Quebec			$12	http://www.cleanenergy.gc.ca
Solix	CO	0.01	0.01	$36.9	www.solixbiofuels.com
SunEco Energy	CA				http://sunecoenergy.com
Xylowatt	Belgium			$4.1	www.xylowatt.com
Yulex Corporation	CA				http://www.yulex.com
Zymetis	MD			$0.75	www.zymetis.com
31 Companies		**0.16**	**110.65**	**$267.91**	

Enzymes & Chemicals					
Company	State	Production in 2011 MGPY	Anticipated 2015 Production MGPY	Private Investment (Millions of $)	Website
AgriVida	MA				www.agrivida.com
Algae Producers	OH				www.algaeproducersinc.com
Allopartis Biotechnologies	CA			$0.75	www.allopartis.com
Arisdyne Systems	OH				www.arisdyne.com
C5-6 Technologies	WI				www.c56technologies.com
Codexis	CA				www.codexis.com
DuPont	DE				www.usa.dupont.com
Dyadic	FL				www.dyadic.com
Genencor	NY				www.genencor.com
GlycosBio	TX				www.glycosbio.com
Haldor Topsoe	TX	0	0.8		www.topsoe.com
HCL CleanTech	NC				
Inventure, Inc.	WA			$1.5	www.inventurechem.com
Myriant	MA			$60	http://www.myriant.com
Novozymes	CA				www.novozymes.com
Segetis	MN				www.segetis.com
16 Companies				**$62.25**	

Related Technology						
Company	State	Fuel Type	Production in 2011 MGPY	Anticipated 2015 Production MGPY	Private Investment (Millions of $)	Website
Agricultural Waste Solutions	CA	Biogas				www.agwastesolutions.com
AgriFuels	CT	Consulting				www.agrifuels.com
AltAir Fuels	WA	Aviation	0	100		www.altairfuels.com
Blendstar	TX	Distribution				www.blendstarllc.com
Blue Marble Energy	WA	Biogas				http://bluemarbleenergy.net/
Bodega Algae LLC	MA	Equipment				http://www.bodegaalgae.com/
Chemrec	NC	Natural Gas	0.58	30.58	$0.03	www.chemrec.se
Clean Energy	CA	Natural Gas				www.cleanenergyfuels.com
Dynamotive	BC	Bio-oil	1.01	1.01	$10.5	www.dynamotive.com
Enviromech Industries	CA	Natural Gas				http://emifuel.com/
Global Green Solutions	BC	Biomass steam			$3.8	www.globalgreensolutionsinc.com
GreenShift Corporation	NY	Other				www.greenshift.com
Live Fuels	CA	Bio-oil	.01	.01	$10	www.livefuels.com
Michigan Biotech Institute	MI	Consulting				http://www.mbi.org/
Nella Oil	CA	Distribution				http://nellaoil.com
Origin Oil	CA	Algae				www.originoil.com
Propel	CA	Distribution				www.propelfuels.com
R-Qubed	TX	Biogas			$0.15	www.r-qubedenergy.com
Solena Group	CA	Aviation		16	$10	www.solenafuels.com
Ze-Gen	MA	Biogas				www.ze-gen.com
20 Companies			**1.6**	**147.6**	**$34.48**	