ENVIRONMENTAL ENTREPRENEURS®

E2 ADVANCED BIOFUEL MARKET REPORT 2014

Executive Summary

E2's fourth annual Advanced Biofuel Market Report catalogs the growths and challenges in the advanced biofuel industry and provides updates since the publication of the 2013 report. The scope of this project includes advanced biofuel producers and related companies in the United States and Canada. Each project included in this report achieves at least a 50% reduction in carbon intensity over a petroleum baseline, as measured by the California Air Resources Board.

We develop estimates of production capacity in the industry through 2017. This report does not project actual production volumes since this variable number is often below capacity, and may not be reported until after the fact. Our low-end estimates count projects with demonstrated progress towards completion, including financing, permitting, construction, or some combination. Our high-end estimates include all active companies we identified, although we discount some capacity estimates. We also use Cleantech Group's industry financial data and correspondence with companies to determine the viability of certain projects as well as develop industry-wide financial figures.

Key Figures

- Capacity in 2014 is approximately 800 million gallons gasoline equivalent
- Capacity in 2017 may reach over 1.7 billion gallons gasoline equivalent
- 165 facilities planned, under construction, or operating from 180 companies
- Nearly $4 billion in private investment into active advanced biofuel producers and value-chain companies since 2007 and
- $200 million in new private investments since our last report
- Over $848 million in grants to advanced biofuel producers since 2007

POET's Project Liberty cellulosic ethanol facility in Emmetsburg, IA, which began production in September 2014. Photo courtesy of POET.

Our analysis reveals a decrease in capacity over previous years and downward trends in financial metrics. Biodiesel remains the dominant biofuel through 2017, but we project increasing contributions from other fuels, in particular drop-in hydrocarbons and cellulosic ethanol. As the industry matures, some companies have ceased operations or shifted their focus to other markets. Many companies, however, continue to move steadily towards commercialization, with a number of firms expecting to begin production at commercial scale by the end of this year.

Policies like the federal Renewable Fuel Standard and California's Low Carbon Fuel Standard continue to be the primary drivers for market development, although there remain industry challenges related to regulatory uncertainty. Most notably, the EPA was delayed this year in its annual announcement for the Renewable Fuel Standard volumes. This regulatory instability leads to decreased investment, which further exacerbates other challenges associated with commercialization. In addition, in 2014 the LCFS was frozen at 2013 compliance volumes during a re-adoption period following a court decision. A number of promising plants have been delayed or idled because of difficulties in production or financing within this new industry.

A trend in 2014 has been innovation in some companies' paths to commercialization. While many companies continue to commercialize with a large biorefinery, other companies are looking at more distributed generation models that are less capital and feedstock intensive. We also look at trends in feedstock price and utilization to paint a clearer picture of this important component of the industry.

This report continues to see valuable potential for advanced biofuels to have a substantial impact on the transportation sector in the United States. Despite some setbacks, there are many companies moving steadily towards commercialization.

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Glossary

advanced biofuel	Liquid fuels made from non-petroleum sources that achieve a 50% reduction in carbon intensity compared to a petroleum fuel baseline according to the California Air Resources Board.
biodiesel	Fatty acid methyl ester fuel, derived from vegetable oils, animal fats, or other waste oils. Commercially available diesel replacement. In this report, considered advanced only if made with non-virgin oils.
butanol	Energy dense alcohol formed through fermentation of biomass. May be blended into gasoline at higher percentages than ethanol.
carbon intensity	An indicator of the emissions associated with a particular fuel pathway. Measured in grams of carbon dioxide equivalent (CO_2e) per megajoule.
cellulose	Non-food based form of biomass.
commercial facility	Operated with the intention of selling the product at a profit. Product is readily available and facility is operated continuously.
conventional biofuel	Also called first-generation biofuel. Encompasses starch-based ethanol and virgin-oil-based biodiesel. Reduces carbon intensity by 5-30% from a gasoline baseline. Feedstocks used for conventional biofuels include corn, wheat, sugar, soybean and palm oil.
crude oil	Petroleum before it is processed and refined into fuel. Known as biocrude when processed from biomass, which may be refined into renewable gasoline, diesel, or jet fuel.
demonstration facility	Facility used to demonstrate technology and full commercial process at a small scale. May not be operated continuously or at a profit.
dimethyl ether (DME)	Similar to propane. May be blended into diesel to boost butane levels.
drop-in fuel	Renewable hydrocarbons that can be refined into gasoline, diesel, or jet fuel. Can be used in existing vehicles and pipelines with no modifications to vehicle technology or infrastructure.
enzymatic hydrolysis (EH)	Biochemical process to convert cellulose to sugar with enzymes. Used to produce ethanol.
ethanol	Alcohol that can be blended into gasoline. In U.S., blended at 10% to enhance octane levels. This report focuses on cellulosic ethanol.
ethanol equivalent	Liquid fuel measured from an ethanol energy content basis. Ethanol has two-thirds the energy content of gasoline. RFS uses ethanol equivalencies.
feedstock	An input that is processed or otherwise converted to biofuel. In this report, most feedstocks are biomass-based.
gasification	Frequently-used process to heat biomass for conversion into liquid fuels. Can be used to produce a variety of fuel types.
gasoline gallon equivalent (gge)	The amount of alternative fuel equivalent to one gallon of gasoline.
hydrocarbon	Chemical compound made of carbon and hydrogen. Found in petroleum products.
jet fuel	A liquid hydrocarbon suitable for use in airplanes. Refined from biocrude and renewable feedstocks.
pilot facility	Smaller lab-based facility, designed for research purposes.
pyrolysis	Thermochemical process similar to gasification, but performed in the absence of oxygen. Used to produce a variety of fuels. Includes catalytic cracking of carbon bonds.
renewable diesel	Also called advanced diesel. Made by hydroprocessing of vegetable oils, algal oils, or animal fats. As a liquid hydrocarbon, has very similar properties to petroleum diesel. Functions as a “drop-in” fuel.
renewable gasoline	Also called advanced gasoline. May be refined from a gasification or pyrolysis process. Is chemically similar to petroleum gasoline. Functions as a “drop-in” fuel.
transesterification	Process used to produce biodiesel from fats, oils, or greases.

Introduction

Purpose of Report

The fourth annual Advanced Biofuel Market Report serves to catalog the progress and challenges in the advanced biofuel industry and provide updates on past reports. Advanced biofuels have the potential to replace petroleum-based fuels in the transportation sector. As the industry continues to progress towards commercialization domestically and worldwide, there are also roadblocks that slow the industry's development.

E2 produces this report for policymakers, industry professionals, and researchers as an introduction to the industry and overview of issues for consideration. We provide this resource to facilitate the dissemination of information on advanced biofuels.

Report Scope

E2 tracks advanced biofuels that achieve a 50% reduction in carbon intensity threshold according to the California Air Resources Board (ARB), which assesses total lifecycle impacts of a given biofuel's production. ARB and the Environmental Protection Agency (EPA) both assess the carbon intensity of fuel pathways.

Scope of Report		
Fuel/Pathway Type	**E2 Advanced Biofuel**	**EPA Approved Advanced Biofuel**
corn ethanol or butanol		
sugarcane ethanol		✓
biodiesel (non-virgin oil)	✓	✓
biodiesel (virgin oil)		✓
cellulosic ethanol	✓	✓
cellulosic butanol	✓	
drop-ins from non-food sources	✓	✓
new technologies awaiting EPA approval (e.g. algae, planted trees)	✓	

Table 1. Fuels within report scope versus fuels qualifying as advanced under EPA definitions

As detailed in Table 1, there are some pathways that ARB has approved that EPA has not, and there are a few fuels that the EPA considers advanced that do not meet E2's criteria.

E2 reports on biofuel facility capacity and not production quantities, which may result in differing numbers from other industry analyses. In this nascent market, production fluctuates, is frequently less than total capacity, and is not reported until after the fact. Since production is variable, E2 tracks the more fixed capacity numbers.

Cellulosic ethanol being shipped from American Process Inc.'s Alpena biorefinery. Photo by Alex Wisniewski, courtesy of American Process Inc.

Key Findings & Conclusions

Since E2's third annual report in 2013, the advanced biofuel industry has had both major developments and some significant setbacks. As the industry matures, partnerships, mergers and acquisitions are key to information sharing and process optimization. Some companies have ceased operations or shifted their focus to other markets. Many companies, however, continue to move steadily towards commercialization, with a number of firms expecting to begin production at commercial scale in 2014. We see particular progress for cellulosic ethanol facilities, including the first production of EPA-qualifying cellulosic ethanol delivered in May of 2014. As noted in the 2013 report, there have been some mergers and acquisitions in the past year; a common trend in a maturing industry. For example, Renewable Energy Group acquired LS9, Syntroleum and Dynamic Fuels, and appears poised to make other acquisitions.

The regulatory backdrop of 2014 played a significant role for the biofuel industry, as there was uncertainty around RFS volumes. Moreover, the EPA's draft rules called for reductions in those mandated volumes. For the majority of the year, the numbers were unknown, thereby casting downward pressure on the credit prices and investments in the marketplace.

A notable trend in 2014 has been innovation in some companies' paths to commercialization. While many companies continue to commercialize with a large biorefinery, other companies are looking at more distributed generation models, which are less capital and feedstock intensive.

There have been some significant challenges to commercializing advanced biofuels in the United States, and 2014 has proven to be one of the most difficult regulatory periods. The companies that continue to weather these challenges have developed more resilient business models and backup plans as a result. Companies are focused on driving commercial completion, even if delayed from initial plans.

Advanced Biofuel Industry Overview

What are Advanced Biofuels?

E2 defines advanced biofuels as liquid fuels made from biomass that achieve at least a 50% reduction in carbon intensity (carbon dioxide emissions per unit of energy in the fuel) over petroleum fuel products and minimize other impacts, like food production and ecological diversity. Gasoline, diesel, and jet fuel can all be produced at lower carbon intensity than the traditional petroleum version using a variety of feedstocks and technological processes.
Generally speaking, biofuels are made by sourcing a renewable biomass to serve as a feedstock. The biomass is aggregated at a central point and may receive pre-treatment prior to shipping to a biorefinery. At the biorefinery, the biomass is processed into a liquid fuel form. After processing the fuel is "neat", or in pure form. Like petroleum products, the biofuel is then blended with other fuels into its finished form before final distribution to the end user. Depending on the fuel type, there are many variations to this process and distribution.

Algenol's photoreactor bags converting algae to ethanol at its Florida facility. Photo courtesy of Algenol.

Primary Benefits of Advanced Biofuels

Advanced biofuels have the potential to achieve substantial benefits in the transportation sector, over both petroleum-based fuels and first-generation biofuels like corn ethanol or soybean-based biodiesel.

There are, and will continually be opportunities for all biofuels and feedstocks to further reduce their greenhouse gas emissions, food and land use impacts. Companies both inside and outside the scope of this report should remain competitive by looking for practices to incrementally decrease their carbon profile, and seek accreditation for their process through well-regarded, third party sustainability certifications like Roundtable on Sustainable Biomaterials.

Reducing Greenhouse Gas Emissions

Advanced biofuels, as defined in this report, emit half (or less) of the greenhouse gases associated with production and use when compared to petroleum counterparts. ARB estimates "well-to-wheel" life-cycle emissions for biofuels, including estimates of emissions associated with indirect land use changes. Some advanced biofuels may achieve substantially greater reductions in carbon intensity, including some processes that can be considered carbon negative.

Next Generation Feedstocks

The methodology for qualifying a particular fuel as advanced includes an evaluation of the type of feedstock used. Feedstocks for advanced biofuel tend to be byproducts or waste products that otherwise have little value, like agricultural residue or used cooking oil. Although some advanced biofuels rely on dedicated energy crops, agricultural land typically yields higher value when used for food crops, so growers seek land or growing seasons that are otherwise not productive. There is significant research going into developing biomass with optimal characteristics for biofuel production and that can help remediate soil.

Job Creation

As with many young industries, there will be job opportunities created with the increased development and deployment of advanced biofuels. Jobs associated with advanced biofuel production include temporary construction jobs for facilities, permanent production employees, and numerous employees for research and development. There is also substantial potential for job creation along the supply chain, including in feedstock development and distribution. For more information about job multipliers resulting from biofuel production, see E2's 2012 Biofuel Market Report.

Capacity through 2017

	2014		2015		2016		2017		Count	
	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
Biodiesel	512	619	512	748	512	904	512	1,094	123	123
Drop-in	214	216	214	216	309	326	319	347	15	27
Ethanol	58	57	97	97	115	170	182	215	26	27
Other	2	2	2	2	20	20	60	60	1	3
TOTAL (volume)	784	893	824	1,063	955	1,421	1,072	1,716	165	180
TOTAL (gge)	819	933	846	1,095	878	1,444	1,056	1,719		

Table 2. E2 advanced biofuel capacity projections, rounded to nearest million gallons, 2014-2017

Methodology

This report estimates the capacity of the advanced biofuel industry through 2017. We examine all companies we could identify that are currently working to produce advanced biofuels in North America. Relying on publicly available information and direct correspondence with companies and industry experts, we eliminate companies with no signs of activity and discount some capacity estimates to arrive at our high-end figures for fuels other than biodiesel. The companies included in our high-end estimates are documented in 0.

Our low-end production capacity estimates include those facilities with demonstrated progress towards completion, including some combination of financing, permitting, location, or other details. The companies included in our low-end estimates are documented in Appendix B.

For most fuel types, E2 tracks capacity and not production, since capacity is generally fixed. Biofuel production varies by month based on many factors, including spot prices, tax and carbon credits, and feedstock availability. These fluctuations make forward-looking production numbers inherently difficult, so E2 chooses to track capacity to reflect the total possible production, given correct market conditions such as favorable biomass prices, high credit value of LCFS and RFS, and end product spot price.

The biodiesel figures included in our low- and high-end capacity estimates differ from other advanced fuels. Biodiesel numbers alone reflect anticipated production rather than capacity. Biodiesel is already available at commercial scale, with annual production over 1 billion gallons and capacity substantially beyond annual production at more than 2 billion gallons.[1] Demand for biodiesel is determined almost entirely by the Renewable Fuel Standard mandate for biomass-based diesel, which EPA reviews and updates on an annual basis. We report the fraction of domestic biodiesel production attributable to non-virgin feedstocks.[2] Biodiesel capacity for companies within our scope is over 1.5 billion gallons, with an industry-wide total of nearly 2.5 billion gallons, documented in Appendix C.

A summary of E2's findings are presented in Table 2.

Employee at Edeniq's pilot cellulosic ethanol facility in Visalia, CA. Photo courtesy of Edeniq.

[1] U.S. Energy Information Administration, May 2014 assessment of biodiesel capacity. Available on the web at: http://www.eia.gov/biofuels/biodiesel/production/table4.pdf

[2] Data on biodiesel feedstock breakdowns provided by National Biodiesel Board and based on 2013 actual

[2] Data on biodiesel feedstock breakdowns provided by National Biodiesel Board and based on 2013 actual production. Forward-looking high-end estimates based on a weighted moving average of the change in required volumes.

Active Companies

This year E2 found 181 companies actively working on advanced biofuels in North America. Although this is an increase from last year's reported number of 158, we do not consider this a directly comparable number. We were able to find data on many biodiesel companies previously not included. There have also been some decreases since last year in other fuel categories, either due to non-activity or companies pursuing feedstocks or finished products that move them outside our scope. As more data about this industry becomes publicly available, we are able to better research this number.

These companies have at least 167 commercial facilities and 9 demonstration facilities that are either already operating, are under construction, or are in advanced planning stages. The majority are multi-feedstock biodiesel facilities. Of the facilities focused on advanced fuels other than biodiesel, at least 5 are currently operating at commercial scale or expect to begin production by the end of 2014.

We also see an increasing number of first-generation biofuel companies exploring technologies to incorporate cellulosic feedstocks into their production. Companies like Sweetwater Energy and Edeniq are partnering with corn ethanol facilities to increase yields and allow a portion of the ethanol produced to qualify as cellulosic ethanol.

E2 also tracks companies that provide feedstocks, catalysts or enzymes, or other related technologies associated with advanced biofuel production. We identified 93 companies working along the advanced biofuel value chain, which are listed in Appendix D, Appendix E, and Appendix F.

2014 Capacity

In 2014, advanced biofuel capacity is between 819 and 933 million gallons per year of gasoline gallon equivalents (gge) as shown in Table 3. This is a slight decrease in our estimates relative to last year's projection, since some projects have ceased operations, others have fallen outside of our scope, and a number were delayed until 2015 or later. Late 2014 is particularly promising for cellulosic ethanol, as a number of facilities are scheduled to come online this year and next.

Some facilities that began production in 2013 or before are currently idle as companies work out production bottlenecks or other issues. We include these facilities in our capacity estimates and expect many of them to begin production again within the next year.

Table 3. Advanced biofuel capacity in millions of gallons, 2013 and 2014.

	2013		2014	
	LOW	HIGH	LOW	HIGH
Biodiesel	512	512	512	619
Drop-in	213	213	214	216
Ethanol	12	11	58	57
Other	2	2	2	2
TOTAL (volume)	737	738	784	893
TOTAL (gge)	787	787	819	933

2015 and 2016 Capacity

Looking forward, we see significant increases in production capacity, particularly of drop-ins and cellulosic ethanol in 2016. By 2016, there may be the capacity to produce over 1.4 billion gallons of advanced biofuels. Although the rule is subject to review, the RFS will require approximately 7.25 billion gallons of advanced fuels to be blended into the fuel mix in 2016. There are some fuels that will help meet this requirement that are not included in our capacity figures (see Table 1). Beyond fuels produced in the U.S., we expect increasing imports will fulfill any unmet portion of the RFS and other fuel standards. There are already substantial biodiesel imports, including over 300 million gallons in 2013, and we anticipate that a number of other advanced international projects will be complete by 2016.[3]

[3] Energy Information Administration. U.S. Biodiesel Data Summary. <http://www.eia.gov/tools/faqs/faq.cfm?id=927&t=4>

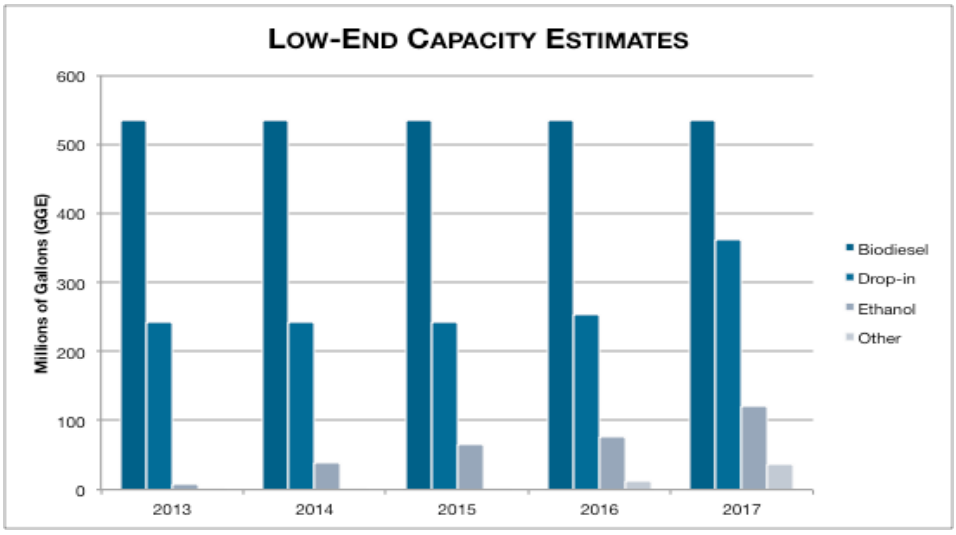

Figure 1. Low-End Capacity estimates in gallons of gasoline equivalent, 2013-2017

2017 Capacity

Although there are many factors that will determine the future trajectory of the industry, our data shows capacity in 2017 will be up to 1.7 billion gallons gge, with increasing contributions from alternative fuel products like butanol and DME. This is equal to approximately .8% of total projected fuel usage in 2017.4 Together with conventional biofuels, total biofuel blending may be around 9% of all fuel used in 2017. It is important to note that regulatory changes have significant impact on the industry and may alter longer-term capacity estimates.

There may be additional advanced fuel capacity much higher than reported from biodiesel if biodiesel facilities that currently accept only virgin oils modify their facilities to be multi-feedstock. There are at least 27 companies currently producing biodiesel not included in our current scope that may contribute to future capacities.

There may also be substantial additional capacity from currently undisclosed projects. Edeniq, for instance, has a number of partnerships in development with corn ethanol facilities to use its technology to process cellulosic feedstocks and increase yields. We anticipate increased capacity volumes from these and other projects. There may also be additional capacity announced in the future as companies secure approval for a new fuel pathways from the EPA or ARB. Finally, there is potential for landfill gas and other forms of biogas used in the transportation sector to meet fuel requirements and reduce the carbon intensity of the fuel mix. Although these projects are not counted in our figures, they are considered advanced by the EPA and we expect them to make a meaningful contribution to fossil fuel replacement in the transportation sector.

Meeting Fuel Standards

Low Carbon Fuel Standard

The LCFS requires an estimated 17 million metric tons (MMT) of emissions reduction in 2020. Other alternative fuels like natural gas and electricity will contribute significantly towards compliance, as will conventional biofuels. ICF International provides compliance scenarios that illustrate how other fuels complement advanced biofuels to provide total LCFS compliance in 2020.[5] For illustrative purposes, E2 estimates that one-half of LCFS reduction targets are needed from advanced biofuels[6] (although ICF estimates this number is likely less). The LCFS requirement in Table 4 represents one-half of total program reductions. E2 tracks forecasts through 2017, as conservative industry forecasts do not extend past 2017. The advanced biofuels that E2 tracks alone can provide 9-15 MMT of

[4] The Energy Information Administration projects total fuel usage in 2017 as approximately 211 billion gallons. Energy Information Administration. Annual Energy Outlook 2014. Transportation Sector Key Indicators. <http://www.eia.gov/analysis/projection-data.cfm#annualproj>

[5] http://www.caletc.com/wp-content/downloads/LCFSReportJune.pdf

[6] Other entities' illustrative compliance scenarios have similar findings. For example, see ARB's 2020 compliance scenario breakdown, slide 14: http://www.arb.ca.gov/fuels/lcfs/lcfs_meetings/lcfs_compliance_curves_and_cost_containment_10232014_pres.pdf

reductions in 2017, with the potential for significant over-compliance prior to 2017. However, this represents total domestic production, and not all advanced biofuels will come to California. If there is tight supply to meet LCFS targets, credit prices will increase, thereby attracting more fuels into the California market.

reflected in this report's reduced biofuel projections. There remains some uncertainty as to how the industry will respond once EPA volumes are established. Although some projects may never recover, we expect biofuel companies to have increased interest in West Coast LCFS markets, where the policy outlook is more certain at this time.

	2013	2014	2015	2016	2017
LCFS potential reduction from advanced biofuels (MMTCO2e)	2.36	3.31	5.21	6.93	9.60
Emissions Reductions provided by E2-tracked fuel (Low-End)	7.15	7.44	7.69	7.96	9.34
Emissions Reductions provided by E2-tracked fuel (High-End)	7.15	8.57	10.17	13.23	15.84

Table 4. Advanced biofuel potential to meet LCFS targets through 2017.

Renewable Fuel Standard

At the time of press, RFS volumes for the 2014 standard and beyond are unknown. EPA is assessing volumetric standards to reflect market potential, and in November 2014 announced that it will delay any announcements until 2015.

There are some fuels and fuel alternatives that will help the transportation sector comply with the RFS that are not included in our report. For instance, the EPA anticipates that landfill and anaerobic digester gases will meet a substantial portion of the advanced fuel category.

Policies that Drive Demand

A number of federal and state policies exist that create incentives for advanced biofuel development and production. Most serve to either reduce the cost of developing and producing fuels, such as tax credits, while others create a price incentive to blend and sell gallons of advanced biofuels.

Renewable Fuel Standard

Created in 2005 and updated in 2007, the federal standard establishes volumetric mandates for biofuels in the U.S. fuel mix. There are four broad, nested categories for fuels under the RFS: renewable, advanced, cellulosic and biomass based diesel. The strongest market signal for biofuel development, the RFS has also been the most contentious over the past year. Responding to concerns about ethanol blend requirements outpacing the 10% blend present in most gasoline, the EPA substantially reduced the draft 2014 volumes. The resulting political outcry on both sides of the issue caused EPA to delay any announcement. Ultimately, the fledgling advanced biofuel producers were impacted the most, with almost 18 months of unknown and potentially reduced fuel volumes. This is

Low Carbon Fuel Standard

California's Low Carbon Fuel Standard was established in 2007 and requires a 10% reduction in the carbon intensity of the state's fuel mix by 2020. Since last year's report, the LCFS has won some legal challenges, and the program's credit prices reflect the renewed confidence in the program's longevity. After RFS draft volumes were announced for 2014, many biofuel producers began shipping their product to California to capture the additional credit value. As discussed in the following section, the LCFS is currently being re-adopted by California's Air Resources Board, with several enhancements to the program expected as part of this process.

Tax Incentives and State Policies

Federal cellulosic and biodiesel tax credits expired at the end of 2013. Recent legislation may renew the biodiesel tax credit for 2014, but at the time of press, the outcome of this bill is unknown. In the past tax credits passed near the end of a calendar year have been applied retroactively for an industry.

State-level policy and financial incentives also continue to encourage biofuel production and use. Support types may be grouped into the following categories:

- **Tax Incentives**: Tax credits or exemptions applying to production or investments in biofuels.
- **Grants and Loans**: Public funds that directly support the funding of biofuel research or projects.
- **Government Vehicle Policies**: Requirements for government vehicle fleets to contain alternative fuel vehicles, or blending requirements for the fuels used by the fleet.

- **State-level Fuel Standards**: Low-carbon fuel standards or blend requirements.

Since our 2012 report, which examined state-level policies in detail, the total number of states offering incentives for biofuel has increased.[7]

Type of Support	Number of States
Tax Incentives	32
Grants and Loans	23
Government Vehicle Policies	40
State-level Fuel Standards	9
One or more of the above	49

Industry Challenges

Regulatory Instability

Regulatory instability has been a particularly acute challenge since our 2013 report. The California LCFS won a federal court challenge against its constitutionality vis-à-vis the commerce clause. However, a separate state-level court case found that Air Resources Board needed to address some violations of the California Environmental Quality Act. Therefore, the standard has been frozen at 2013 levels through 2015. In October 2014, Air Resources Board announced it will still maintain the 10% compliance standard in 2020, so the compliance curve from 2016-2020 will be somewhat steeper than originally designed. LCFS is being implemented as planned and, although biofuel volumes have varied from original expectations, the program's flexibility to allow for electricity, natural gas, and other alternative transportation fuels positions the program to be on track for 2020 compliance.

In the fall of 2013, both leaked and official documents from the U.S. EPA revealed that the administration was considering reducing the RFS volume mandates, to account for mandates approaching the "blend wall" and causing credit price spikes. The reduction in required biofuel volumes had a chilling effect on program credit prices and fuel demand, thus stalling some planned capital outlay. The politics of the rulemaking stretched on through 2014, further delaying many plans and tightening cash flows. The lowered credit price made many fuel producers ship their product to California, hoping to gain incremental value from LCFS credits. In turn, this caused LCFS credit prices to decline significantly in the first half of the year.

Many companies have cited regulatory stability as critical to the continued development of the advanced biofuels industry. For example, in reference to the cellulosic ethanol facility opened in Fall 2014 in Kansas, Abengoa's CEO stated that "Abengoa had committed to investing in the plant on the understanding that the renewable fuel standard would be there to support it."[8]

Once the EPA's 2014 rule is soon published and the LCFS court proceedings are now in the past, we can expect the regulatory market to stabilize in comparison to the past 12 months, thus encouraging more investment and capital expansions.

Feedstock Availability

Consistent, tested and reliable feedstock availability is another key to unlocking commercial success for advanced biofuels. Dozens of companies are working on optimizing many feedstocks, both from waste and purpose-grown sources. These companies will be poised to deliver valuable biomass as the industry achieves greater scale in 2016 and 2017. So far in the United States, two main cellulosic feedstocks have proven to be commercially available, economical and have a consistent chemical composition: wood chips and corn stover. Companies that have begun or will begin production in the next year or two are co-located in areas where these feedstocks may be found in abundance, which includes idle pulp and papermills in the Southeast, or alongside corn farmers in Iowa.

Fats, oils and greases are also an important constraint to biodiesel and renewable diesel production. Many ethanol facilities are beginning to express the corn oil from kernels, as this oil is scored with very low carbon intensity and is gaining market value. Other sources, like restaurant grease, are gaining value and maturing their supply chain (and security against theft) as a

[7] Department of Energy. Alternative Fuels Data Center. Accessed August 2014. < http://www.afdc.energy.gov/laws/>

[8] Crooks, Ed. "Abengoa warns legal reverse threatens to smother biofuel industry." *Financial Times.* <http://www.ft.com/cms/s/0/851b7afe-5578-11e4-89e8-00144feab7de.html#axzz3Gq82Py5U>

result. This report includes a more detailed discussion of feedstock utilization and pricing on page 17.

Operating Costs

Success in this industry requires that advanced biofuels become cost-competitive with their petroleum-based counterparts, which means advanced biofuel producers must attempt to minimize operating costs. Different processes have varied inputs that act as the key constraint to keep operations profitable. For most companies, however, the key to low operating costs is low biomass costs. Another big consideration is the cost of any enzymes needed for biomass breakdown. Overall, publicly available information on operating costs is hard to come by, making academic reviews the best resource for this information. Academic resources suggest that operating costs may be difficult on a competitive basis in early years of facility operation, but with process enhancements and expansion, profitability is possible without any tax incentives at large scale.

Capital Costs

Accessing affordable and sufficient project capital is equally as important to future growth as competitive project operating costs. The availability of sufficient capital continues to be a challenge for the advanced biofuel industry. Large-scale biorefineries require substantial capital to construct, with capital expenses $5-$20 per gallon depending on the size of the facility.[9] Huge capital outlay for biorefineries can make companies run short of cash before commercial operation is even at full scale. In 2014, after beginning production, KiOR began idling its facility to work on bottlenecking and other process optimizations when it ran out of money. As other companies build commercial production strategies, more time will be needed to test processes and operate facilities before banking revenue. Particularly in an unstable regulatory climate, it can be difficult to secure sufficient capital to both develop and refine production processes at a nascent level of maturity and scale. To bypass some of these large upfront capital costs, many companies are assessing bolt-on projects to make cellulosic feedstocks acceptable at traditional biofuel facilities, and smaller scale facilities that make projects less than $10/gallon in capital financing.

Scaling up demonstrated processes

The typical process for developing an advanced biofuel production system involves extensive research and development, testing the process at small volumes at a demonstration level, and ultimately scaling up to full capacity. As discussed in the capital costs section, there are often bottlenecking or other production process challenges that reveal themselves when a company begins operations. It may require additional research and capital to optimize a process and achieve stable production at a commercial scale. INEOS Bio began production in 2013 but has since idled its facility to improve the technology and plant operations. Although some reworking is to be expected with any new technology and facility, scaling up presents a delay for the industry to achieve commercial scale.

International Markets

The focus of this report is the domestic advanced biofuel industry, but international developments can impact the domestic market in multiple ways. Far from operating in a vacuum, the U.S. biofuel industry is part of a global flow of technology, information and of course fuel. The exchange of information on best practices and technology advancement improves operations here and overseas. Beta Renewables' licensed technology is currently or scheduled to be used in production facilities in North Carolina, California, Spain, Brazil, and China. Sapphire Energy is in collaboration with oil giant Sinopec on demonstrating the feasibility of algae-derived crude oil through projects also in China.

Importing fuel is also a way to meet domestic standards. Neste Oil's renewable diesel produced in Finland and Singapore is qualified as advanced under the RFS and is imported in significant quantities (as much as 25 million gallons per month)[10]. LanzaTech, which operates a woody biomass pilot facility in

[9] Solecki and Epstein, Scaling Up Advanced Biofuels. California Council on Science and Technology. May 2014. Available at: http://www.ccst.us/publications/2014/2014biofuels.pdf

[10] Energy Information Administration. Petroleum & Other Liquids. U.S. Imports by Country of Origin. Accessed July 30, 2014. <http://www.eia.gov/dnav/pet/pet_move_impcus_a2_nus_EPOORDO_im0_mbbl_m.htm>

Georgia, has also opened demonstration facilities in China and Taiwan, expanding its international production forecasts. Finally, Amyris and Solazyme's Brazilian presence and likely commercialization projects there highlight the international market's role in bringing fuels to the United States.

All told, the United States imported 621 million gallons of renewable fuel in 2013. That total consisted of 315 million gallons of biodiesel[11] and 306 million gallons of renewable ethanol[12] from international producers. Appendix G presents an expanded list of international companies and projects that may have an impact on the U.S. advanced biofuel market.

Solazyme Bunge renewable algal oil facility, courtesy of Solazyme.

Financing

Overview

Many advanced biofuel projects are capital intensive and require substantial upfront investment and other financing. The industry depends on private and public investments as well as developing strategic partnerships with customers or other interested parties. As the industry matures, there is an increasing number of acquisitions and consolidation, in part because larger established companies may have more access to capital than newer, smaller companies.

This year we see a decline in the majority of financial metrics we track. Declining investment could be triggered by many factors, but most notable is the regulatory instability, particularly around the RFS and LCFS. The price premium generated by this and other policies is a driver of financial feasibility, and investors require confidence that these policies will remain in place.

Private Investment & Debt Financing

Industry-wide Figures

E2 tracks companies that produce advanced biofuels as well as companies that work along the value-chain, including feedstock producers, enzyme developers, and other related technologies.[13] Since 2007, there has been over $3.7 billion in private equity investments into active production and value-chain projects, as well as over $550 million in debt financing for these projects. Table 5 summarizes the amount of equity investment and number of deals in the advanced biofuel industry by quarter from 2007 to the 2nd quarter of 2014. Since last year's report, there has been over $300 million in new equity investment into the advanced biofuel industry.[14] Overall, the lower investment numbers from Q4-2013 until the present is likely a symptom of the EPA's lowering the drafted volumes for 2014. Without a clear signal for continued, strong demand, investors will likely look for other markets. In September 2014, a group of biofuel company executives wrote a letter encouraging the administration to increase the RFS volumes, explaining that "the current EPA proposal froze investment in cellulosic ethanol not because of the 2014 targets; but rather, because it is not clear whether oil companies will be obligated to hit any annual RFS target going forward."[15] E2 expects that there will be an uptick in investment as the regulatory climate stabilizes over the coming months.

[11] Energy Information Administration. Petroleum & Other Liquids. U.S. Imports by Country of Origin. Accessed August 15, 2014. <http://www.eia.gov/dnav/pet/pet_move_impcus_a2_nus_EPOORDB_im0_mbbl_a.htm>

[12] Energy Information Administration. Petroleum & Other Liquids. U.S. Imports by Country of Origin. Accessed August 15, 2014. <http://www.eia.gov/dnav/pet/pet_move_impcus_a1_Z00_epooxe_im0_mbbl_a.htm>

[13] Investment data provided by Cleantech Group

[14] Variation in financial figures for previous years between reports is a result of the discovery of previously unidentified investments, the identification of companies as non-active, or the inclusion or exclusion of companies from our scope from year to year. Figures reported are for our current list of active and within-scope companies.

[15] Letter quoted by Erin Voegele in "Letters highlight importance to RFS to cellulosic investments." *Ethanol Producer Magazine.* September 12, 2014. <http://www.ethanolproducer.com/articles/11444/letters-highlight-importance-of-rfs-to-cellulosic-investments>

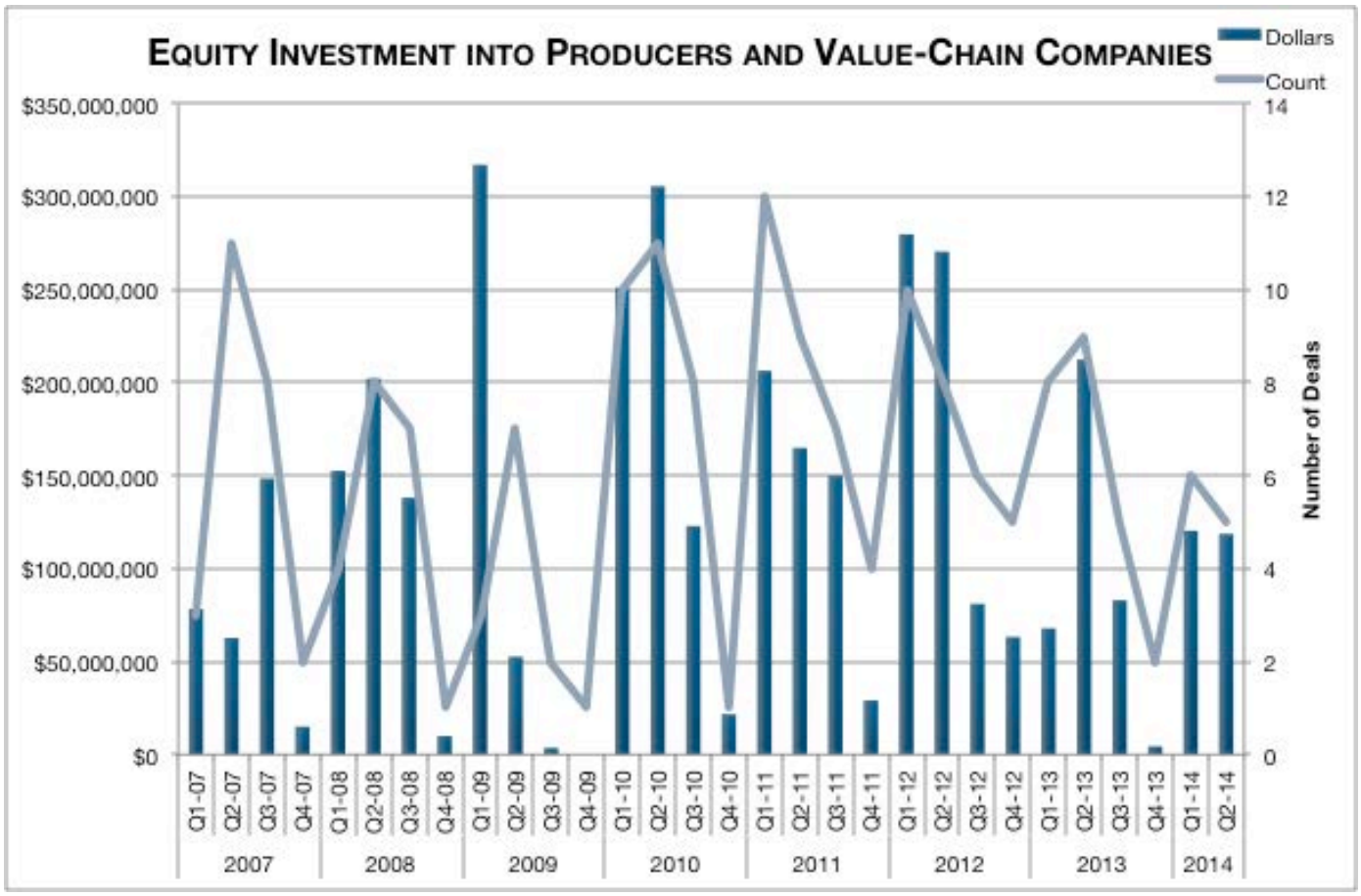

Figure 2. Equity investment into advanced biofuel producers and related companies by quarter, 2007-Q2 2014.

PRODUCTION-SPECIFIC FIGURES

The bulk of financial support for the advanced biofuel industry goes to producers of advanced biofuels since these projects tend to require more capital than other projects along the value-chain (like enzyme development). Since 2007, there has been over $2 billion of private investment into advanced biofuel producers, and over $300 million in debt financing. There has been nearly $200 million in new private investment since last year's report.

Private		
	Equity	**Debt**
Producers Only	$2.1 billion	$357 million
Entire Value-Chain	$3.8 billion	$557 million
Public		
	Grants	**Loan Guarantees**
	$848 million	$707 million

Table 5. Summary of financial data on advanced biofuel companies and related value-chain companies, 2007-Q2 2014.

Public

In support of policy goals and reducing the nation's dependence on fossil fuels and fuel imports, the public sector provides substantial financial support for the advanced biofuels industry. Government agencies, in particular the Department of Energy (DOE) and the Department of Agriculture (USDA) provide grants, loan guarantees, or other forms of financing to spur industry development. E2 identified over $1.7 billion in public support from federal agencies and states to producers and value-chain companies since 2007. Governments provided over $840 million in grants and over $700 million in loan guarantees to currently active companies as summarized in Table 6. A full list of public investments is included in Appendix H. There has been additional public financing beyond these figures that is not listed because companies have since become non-active or fallen outside our scope.

The public sector runs or has run numerous programs to facilitate the growth of advanced biofuels, representing not only funding support, but also a valuable partner that serves to broker industry connections and strategic planning. The USDA continues to solicit applications for funding through a

number of its programs, including the Advanced Biofuel Payment Program. Although the Department of Defense's (DoD) tracked investments are small relative to other agencies, the military continues to play a key role in the advanced biofuel industry as a heavyweight customer. DoD announced over $200 million in grants for military biofuels in Fall 2014. Since biofuels depend on local biomass sources and reduce our demand on foreign crude oil imports, the military has a strong interest in developing biofuels as a component of its national security strategy. The Navy in particular is involved with a number of research projects and is slated to sign off-take agreements in the future as companies move towards commercialization.

	Grants	Loan Guarantees	Total
Department of Energy	$541.7	$133.9	$756.2
Department of Agriculture	$25.6	$573.5	$599
Department of Defense	$225.3	$0	$225.3
Total	$847.9	$707.4	$1,718.3

Table 6. Public investments from 2007-2014 by agency and investment type, in millions of dollars.

Exploring the Business Model

Scale

The scale of a production facility is one of the key components of an advanced biofuel company's business model. As the industry moves towards commercialization, it is worthwhile to examine the relative strengths and weaknesses of various types of biofuel production processes. While there are as many business models as there are companies, we can generally categorize production processes into two broad categories of biofuel scale that we track: traditional large-scale or distributed smaller-scale. The traditional model is a large, centralized facility that may be responsible for growing its own feedstocks, like a dedicated energy crop, or aggregate and store other forms of biomass, like corn stover. In the smaller, distributed models, companies may attach a bolt-on technology to an existing biorefinery so that it can accept additional feedstock types, like corn kernels at a corn ethanol facility, or develop new, small-scale facilities around existing feedstock sources like sorted municipal solid waste. E2 has noticed a trend towards distributed models in recent years, since smaller-scale facilities offer the opportunity for biofuel producers to overcome some of the commercialization challenges associated with larger facilities, and matching production to economically available biomass supply.

Lower Capital Costs

Distributed models, whether bolt-on technologies or stand-alone facilities, require substantially less capital than a traditional biorefinery. Acquiring capital is a continued challenge in the industry, particularly on a large scale. Less capital-intensive projects appear somewhat more resilient to market and regulatory fluctuations. Investors may be more willing to front $50 million dollars versus $150 million, and may be willing to reinvest if a smaller project demonstrates success and replicates the model elsewhere. This reduces the risk to the investor, making these projects easier to finance.

Cost-Effective Feedstock Access

As discussed previously in this report, access to cost-effective feedstocks can be challenging for larger facilities that require feedstocks in greater volumes. Transportation costs may make aggregating feedstocks prohibitively expensive if the feedstock must travel a long distance. There are only a handful of developed supply-chains in existence for particular feedstocks, making it difficult for a facility to cheaply acquire the requisite quantity of feedstock. Distributed models are located at the source of feedstock, reducing transportation costs and some other costs associated with feedstock aggregation.

Incorporation into Existing Processes

Certain distributed technologies may be less risky for current first generation biofuel producers to incorporate into new advanced processes. Rather than building a new plant dedicated to cellulosic feedstocks, current producers can slowly incorporate cellulosic material into their existing production process with bolt-on, smaller-scale technologies. This reduces some of the risk in deploying a new technology.

Distributed models have the potential to overcome many of the industry challenges, although we do not see distributed models achieving equivalent volumes to traditional large-scale facilities in the timeframe of this report. E2 has seen continued progress in smaller-scale distributed models, and we expect to see increased adoption of these technologies in the future.

Feedstocks

Advanced biofuel companies rely on a remarkable variety of feedstocks. Located at the very beginning of the value chain, these inputs represent a critical piece of the economics for biofuels. Feedstock costs represent a substantial share of the cost per gallon for a biofuel, and feedstock availability will in large part determine the viability of a particular project. However, publicly available information about the supply and costs of advanced biofuel feedstocks is scant compared to the wealth of data for first-generation feedstocks like corn and other widely-traded commodities. We therefore took a closer look at the types and quantities of feedstocks used by today's advanced biofuel companies to get a fuller picture of what inputs the industry is and plans to be using.

Feedstock Categories

Table 7 sorts the active advanced biofuel projects identified in Appendix A and Appendix C by feedstock type. We grouped advanced feedstocks into two categories: oil and sugar. We broke these down further into subcategories reflecting the most commonly used sources of feedstock. CO2, utilized by a few companies, was omitted.

Table 7. Number of companies pursuing advanced biofuel production by feedstock type

Feedstock Type	Number of Companies
Fats, Oils, and Greases	
Algae	4
Waste Oils and Fats	128
Fats, Oils, and Greases Total	**132**
Sugar	
Agricultural Residue	15
Energy Crops	4
Waste products	9
Sugarcane	7
Woody Biomass	13
Sugar Total	**48**

Companies using waste oils and fats account for the majority of companies included in this report. This figure includes companies that use waste oil products to make renewable diesel (included on Appendix A) as well as the vast number of American biodiesel companies utilizing waste oils and fats (listed in Appendix C). Although these companies share a feedstock category, both the specific feedstocks used and finished products are quite different. Many renewable diesel producers use fats from slaughterhouses (animal tallow) and produce in large, centralized facilities. Biodiesel producers often source used restaurant cooking oil (yellow grease) and produce at smaller, more distributed scale. These models, however, are not exclusive to either type of finished product.

While securing accessible and affordable feedstock is a challenge to the industry, the range of different feedstocks serves as a strength to an industry that is working to diversify transportation fuel choices.

Conclusion

Between 2013 and 2014 many companies in the industry took solid steps toward commercialization including breaking ground on facilities, turning on commercial plants, and even producing cellulosic ethanol that generated RINs for the first time. With these gains, however, were also continued challenges. Several companies that began production discovered bottlenecks or other issues with their facilities and have since idled the plants for further optimization research.

Regulatory uncertainty remains a continued challenge for the industry, particularly given delays in EPA's announcement of the final volumetric requirements for the 2014 Renewable Fuel Standard. Delays of this kind exacerbate the existing challenge companies face in accessing sufficient capital. We report a decline in investment since 2012, but expect that investments will again increase when the regulatory climate is more stable.

E2 continues to see value in diversifying the United States' transportation fuels, and the role that advanced biofuels can play in both economically and environmentally. Despite a decline in investment and capacity projections, we see a number of companies working carefully and deliberately to overcome industry challenges.

Appendix A. Active Biofuel Producers (High-End)

Appendix A lists the companies E2 identified that are pursuing the production of advanced biofuels in the U.S. and Canada. The table below includes information on plant locations, if one has been announced, anticipated production capacity of announced projects, planned finish product type and feedstock, technology, partnerships, and in some cases clarifying or additional information. The capacities reported for these companies comprise our high-end capacity estimates for cellulosic ethanol, drop-in hydrocarbon fuels, and other fuels (DME and butanol).

Company	Plant Location	Anticipated 2014 Capacity	Anticipated 2017 Capacity	Finished Product	RFS Category	Feedstock	Technology	Partnership	Note
Abengoa	Hugoton, KS	25.00	25.00	Ethanol	Cellulosic	cellulose	enzymatic hydrolysis	Dyadic	
Ace Ethanol (Sweetwater)	Stanley, WI	0.00	3.50	Ethanol	cellulosic	cellulose	enzymatic hydrolysis	Sweetwater Energy	7% of feedstock to come from Sweetwater's cellulosic sugars.
Aemetis	Keyes, CA	0.00	0.00	ethanol	cellulosic	cellulose	enzymatic hydrolysis		EPA qualified Aemetis' biogas-powered sorghum pathway as advanced (D5) in Fall 2013.
Algae Systems	Menlo Park, CA	0.00	0.00	Biocrude	Cellulosic	Algae	Hydrothermal liquefaction	SRI International	
Algenol	Fort Myers, FL	0.10	0.10	Ethanol	Other	algae and CO2	fermentation	BioFields	Achieved 9000 gal/acre yield from algae produced and converted into ethanol onsite.
AltAir Fuels	Los Angeles, CA	0.00	0.00	Renewable diesel and jet fuel	biomass based diesel	camelina	hydroprocessing	United Airlines	
Altranex		0.00	0.00	Renewable Diesel	Biomass based diesel	multiple (jatropha, soy, camelina, carinata, algae, waste grease)	electrochemical		Altranex is researching renewable diesel fuels, including types that are optimized for cold climates.
American Process	Alpena, MI; Thomaston, GA	1.20	1.20	Ethanol	Cellulosic	cellulose/wood	enzymatic hydrolysis	GranBio	Delivered first RIN-qualifying cellulosic ethanol in May 2014.
Amyris	Emeryville, CA	0.01	0.01	Diesel - Renewable and Aviation	Other	sugar	fermentation	Total	

Appendix A: Producers (High-End)

Company	Plant Location	Anticipated 2014 Capacity	Anticipated 2017 Capacity	Finished Product	RFS Category	Feedstock	Technology	Partnership	Note
Aquatech Bioenergy	SD	0.00	0.00	Ethanol	cellulosic	algae			Algae to ethanol + co-products
Archer Daniels Midland		0.02	0.00	Ethanol	cellulosic	cellulose/stover	enzymatic hydrolysis		
Blue Fuel Energy Corporation	Chetwynd, BC	0.00	0.00	Multiple Fuels - Renewable	Other	CO2		Canadian Methanol (Sundance Fuels project)	Plan to produce and blend renewable gasoline for sale into California and other markets.
Blue Sun	St. Joseph, MO	1.50	1.50	Diesel - Renewable	Biomass based diesel	waste oil and fats	ARA's Biofuel Isoconversion	Chevron Lummus Global, ARA Inc	Advancing "enzymatic" biodiesel, a drop-in that doesn't need to be blended. Demo facility launched Spring 2014.
BlueFire Renewables	Fulton, MS	0.00	0.00	Ethanol	cellulosic	woody biomass, mill residue, cellulose	concentrated acid hydrolysis		
Canergy	Brawley, CA	0.00	30.00	Ethanol	cellulosic	energy cane	enzymatic hydrolysis	Beta Renewables, Chemtex	Will produce ethanol using energy cane grown in the imperial valley.
Cellefuel	Brooklyn, Nova Scotia (pilot), Clare, Nova Scotia (commercial plant)	0.00	10.90	Renewable diesel	cellulosic diesel	woody biomass			
Chemtex	Sampson County, NC	0.00	20.00	Ethanol	cellulosic	energy grasses	enzymatic hydrolysis	Beta Renewables	Project Alpha, operating as Carolina Cellulosic Biofuel
Cobalt Technology		0.00	0.00	Butanol, jet fuel	cellulosic	woody biomass, switchgrass	fermentation	US Navy, National Renewable Energy Laboratory	
Cool Planet Energy Systems	Alexandria, LA; Camarillo, CA	0.20	10.20	Gasoline - Renewable	cellulosic	woody biomass	Biomass Fractionation		Smaller-scale, modular facilities. Plan to produce biochar in addition to renewable fuels.

Appendix A: Producers (High-End)

Company	Plant Location	Anticipated 2014 Capacity	Anticipated 2017 Capacity	Finished Product	RFS Category	Feedstock	Technology	Partnership	Note
Diamond Green Diesel	Norco, Louisiana	137.00	137.00	Diesel - Renewable	Biomass based diesel	animal waste	hydroprocess		Joint venture between Valero Energy and Darling International. Began production at Norco facility in June 2013.
DuPont Cellulosic Ethanol	Vonore, TN, Nevada, IA	0.25	30.25	Ethanol	cellulosic	corn stover	enzymatic hydrolysis		
EcoTech Fuels	Hot Springs, SD; Douglas County, GA	0.00	0.00	Renewable Diesel	cellulosic diesel	Multi-feedstock: MSW, agricultural waste, biowastes, woody biomass	anaerobic digestion, gasification, Fischer-Tropsch Gas-to-Liquids, hydrocracking		
Edeniq	Visalia, CA	0.05	0.05	Ethanol	cellulosic	corn stover, bagasse	enzymatic		Received EPA approval for corn kernal pathway. Are developing partnerships with corn ethanol facilities, and project capacity may reach 50 million gallons by 2017.
Emerald Biofuels	Plaquemine, LA	0.00	85.00	renewable diesel	Biomass based diesel	waste fats and oils	catalytic hydroprocess		Honeywell/UOP technology on Dow Chemical site. Permitted.
Enerkem	Edmonton, Alberta; Varennes, Quebec; Pontotoc, MS; Westbury, Quebec (demo)	1.30	21.30	methanol and ethanol	cellulosic	MSW	Thermochem		Inaugurated Edmonton facility in June, 2014.

Appendix A: Producers (High-End)

Company	Plant Location	Anticipated 2014 Capacity	Anticipated 2017 Capacity	Finished Product	RFS Category	Feedstock	Technology	Partnership	Note
Envergent Technologies (Honeywell UOP/Ensyn)	Kapolei, Hawaii	0.00	0.00	Multiple Renewable	cellulosic diesel	Ag waste, pulp, paper, wood, energy crops and algae	rapid thermal processing		Pilot facility for testing purposes.
Ensyn	Ontario, additional U.S. locations	0.00	0.00	Renewable Diesel, Renewable Gasoline	cellulosic diesel	woody biomass	rapid thermal processing	Fibria	Produce oil that can be upgraded into renewable gasoline or diesel
Fiberight	Blairstown, IA	0.00	6.00	Ethanol	cellulosic	MSW	enzymatic digestion and fermentation		Retrofitting corn ethanol facility.
Frontrange Energy (Sweetwater)	Windsor, CO	0.00	3.50	Ethanol	cellulosic	woody biomass, agricultural residue	enzymatic hydrolysis		7% of feedstock to come from Sweetwater's cellulosic sugars. Sweetwater is in the process of acquiring land at Frontrange facility.
Fulcrum BioEnergy	McCarran, NV	0.00	10.00	Jet fuel and diesel	cellulosic diesel	MSW	gasification and Fischer-Tropsch	Waste Management, Waste Connections	
GeoSyn Fuels	Upton, WY	0.00	0.00	Ethanol	cellulosic	cellulose			Acquired former Blue Sugars cellulosic ethanol demonstration facility.
Green Biologics	Columbus, OH; Emmetsburg, IA; Little Falls, MN	0.00	0.00	Butanol	Other	multi-feedstock; corn mash	fermentation	Easy Energy	
Haldor Topsoe	Des Plaines, IL	0.34	0.00	Renewable Gasoline	cellulosic	woody biomass	thermochemical	Gas Technology Institute	
Hawaii Bioenergy		0.00	0.00	Multiple Renewable	cellulosic diesel	woody biomass		Alaska Airlines	Signed an agreement to produce biofuel for Alaska Airlines.
Highlands Envirofuels	Highlands County, FL	0.00	30.00	Ethanol	cellulosic	sugarcane and sweet sorghum	conventional sugarcane milling		Researching sweet sorghum for feedstock with Univ of FL.

Appendix A: Producers (High-End)

Company	Plant Location	Anticipated 2014 Capacity	Anticipated 2017 Capacity	Finished Product	RFS Category	Feedstock	Technology	Partnership	Note
INBICON				Ethanol	cellulosic	cellulose - ag residues	non-chem pretreatment, EH, sugar fermentation	Patriot Renewables	Developing domestic partnerships for cellulosic ethanol production.
INEOS Bio	Vero Beach, FL	8.00	8.00	Ethanol	cellulosic	vegetative and yard waste	thermochemical gasification/bio chemical fermentation		Working on refining and enhancing Vero Beach facility.
Iogen Corporation	Ottawa, Ontario	0.40	0.40	Ethanol	cellulosic	Stover, cereal straw, sugarcane bagasse	enzymatic hydrolysis		
Joule	Hobbs, NM	0.11	0.11	ethanol	cellulosic	CO2	Helioculture Platform	Strategic partnership with Audi to commerciali ze its fuels	Evaluating options for scaling up
LanzaTech (Freedom Pines)	Soperton, GA	0.00	0.13	Ethanol	cellulosic	biomass, industrial gasses	gas fermentation	Virgin Airlines, Concord Blue, Imperium Renewables	Pilot facility at 6000 gallons, demonstration facility at 125,000.
Logos Technologies	Visalia, CA	-	-	Ethanol	cellulosic	cellulose, MSW	enzymatic hydrolysis	Edeniq	Logos Technologies works in partnership with EdeniQ on the Visalia facility.
Mercurius Biofuels				cellulosic diesel and jet fuel	cellulosic diesel	Woody biomass	Renewable Acid-hydrolysis Condensation Hydrotreating		Indiana pilot plant will process 10 tons/day into 800 gallons fuel.
Oberon	Imperial Valley, CA	1.60	60.00	DME	Other	Methanol, methane, biogas, natural gas, stranded gas	GTL	Volvo Trucks, Safeway	Diesel replacement for heavy duty vehicles. Pathway received EPA approval in September 2014.
OPX Biotechnologies				renewable diesel, jet fuel	cellulosic diesel	fatty acid	enzymatic hydrolysis		Project developing under DOE Grant biofuel pathway, otherwise biochemical.

Appendix A: Producers (High-End)

Company	Plant Location	Anticipated 2014 Capacity	Anticipated 2017 Capacity	Finished Product	RFS Category	Feedstock	Technology	Partnership	Note
Pacific Ethanol (Sweetwater Energy)	Madera, CA	0.00	3.5	Ethanol	cellulosic	Sweetwater sugars	biochemical conversion of cellulosic feedstock		Sweetwater Energy will colocate on Pacific Ethanol's Madera facility site.
Phycal	Central Oahu, Hawaii (under construction)	0.01	0.15	multiple Fuels - Renewable	Other	cassava and algae		Tesoro, GE	Ethanol from cassava and other fuels from algae
POET	Scotland, SD & Emmetsburg, Iowa	20.02	25.02	Ethanol	cellulosic	Corn stover, switchgrass, MSW, wheat straw	enzymatic hydrolysis	DSM	Project LIBERTY opened in 2014. Capacity of 20 MG ramping up to 25 MG.
Quad County Corn	Galva, IA	1.00	3.80	Ethanol	cellulosic	corn kernel cellulose			Adding cellulosic ethanol production to its existing corn ethanol plants.
Red Rock Biofuels	TBD	0.00	15.50	renewable diesel and jet fuel	cellulosic diesel	woody biomass	gasification		Signed 3 MG purchase agreement with Southwest Airlines in Fall 2014. Matching gov funds with $5M private capital. Currently in Phase 1 of DoD grant to select facility location. Fluor engineering.
Renewable Energy Group Geismar (Dynamic Fuels)	Geismar, LA	75.00	75.00	Diesel - Renewable	Biomass based diesel	animal waste	Fischer-Tropsch		Renewable Energy Group completed acquired the Dynamic Fuels facility and is investing funds to restart and expand production.
Renewable Energy Group Life Sciences (formerly LS9)	Okeechobee, FL	0.07	0.07	Diesel - Renewable	Other	first and second generation sugars	fermentation		
Sapphire Energy	Columbus, NM and Las Cruces, NM	1.02	1.02	green crude; renewable crude oil	Other	algae	hydroprocessing	Phillips 66 research collaboration, Tesoro as off-take customer, Linde	Plans for 100 million gallon crude oil facility in 2018.

Appendix A: Producers (High-End)

Company	Plant Location	Anticipated 2014 Capacity	Anticipated 2017 Capacity	Finished Product	RFS Category	Feedstock	Technology	Partnership	Note
SG Preston	South Point, OH	0.00	0.00	Diesel – Renewable	Cellulosic	Waste biomass			Announced plans in Aug 2014 for 120 million gallon facility, expected to begin operations in 2017.
Sierra Energy	Sacramento and Fort Hunter Liggett, CA	0.00	0.00	Diesel - Renewable	Cellulosic	MSW	gasification		Planning to license gasification technology.
Solazyme (pilot & demo)	Peoria, IL, Clinton IA and South SF, CA	0.53	0.66	Multiple Fuels - Renewable	Other	Sugar	hydroprocessing	ADM facility for algal oil, American Natural Products	Clinton: 500,000 L, Peoria: 2,000,000 L
Sweetwater Energy	Upstate New York	0.00	3.50	Ethanol	cellulosic				
Virent	North America	0.01	0.01	renewable gasoline, diesel, jet fuel, and aromatic chemicals	cellulosic diesel	plant sugars	catalytic	Shell, The Coca-Cola Company, Honda and Cargill	
	TOTAL	**274.75**	**622.375**						

Summary of Appendix A (Volumes)					
	2013	**2014**	**2015**	**2016**	**2017**
Drop-in	213.2	215.7	215.955	326.225	347.02
Ethanol	11.43	57.45	97.355	170.355	215.355
Other	1.6	1.6	1.6	20	60
Total (Volume)	226.23	274.75	314.91	516.58	622.375

Summary of Appendix A (GGE)					
	2013	**2014**	**2015**	**2016**	**2017**
Drop-in	242.9717	245.8217	246.1607	370.4685	394.1748
Ethanol	7.6581	38.4915	65.22785	114.13785	144.28785
Other (DME, Butanol)	0.96	0.96	0.96	12	36
Total GGE	251.5898	285.2732	312.34855	496.60635	574.46265

Appendix B. Facilities (Low-End)

Appendix B lists individual facilities that E2 expects to come online by 2017. Each of these facilities is associated with a company listed on Appendix A. The table below includes facility-specific information. The capacity associated with Appendix B facilities comprises our low-end estimates of cellulosic ethanol, drop-in hydrocarbons, and other fuels (DME and butanol).

Company	Facility Type	Facility Location	Projected Online	Anticipated 2014 Capacity	Anticipated 2017 Capacity	Fuel Type	RFS Category	Feedstock	Partnerships	Note
Abengoa	commercial	Hugoton, KS	2014	25	25	Ethanol	Cellulosic	cellulose	Dyadic license for enzyme technology	Expect to produce by the end of 2014.
Ace Ethanol (Sweetwater)	commercial	Stanley, WI	2016	0	3.5	Ethanol	cellulosic	cellulose	Sweetwater Energy	Secured permits.
Algenol	pilot	Fort Myers, FL	2012	0.1	0.1	Ethanol	cellulosic	algae	Valero, the Linde Group, Biofields, Honeywell, NREL	
American Process	demo	Thomaston, GA	2013	0.3	0.3	Ethanol	cellulosic	cellulose		
American Process	commercial	Alpena, MI	2012	0.89	0.89	Ethanol then butanol	cellulosic	woody biomass	Cobalt, GranBio	Produced fuel that generated cellulosic ethanol RINs.
Canergy	commercial	Brawley, CA	2017	0	30	Ethanol	cellulosic	energy cane	Beta Renewables, Chemtex	In permitting process for Imperial Valley facility.
Chemtex	commercial	Sampson County, NC	2017	0	20	Ethanol	cellulosic	miscanthus and switchgrass	Beta Renewables, Biofuels Center NC, Novozymes	JV of Chemtex and Gruppo Mossi & Ghisolfi; prototype in Italy is operational.
Cool Planet	commercial	Colorado	2015	0	10	Renewable Gasoline	Cellulosic	cellulose	BP and ConocoPhillips	Broke ground on facility in February 2014 and secured $100M in financing in March.
Diamond Green	commercial	Norco, Louisiana	2013	137	137	Renewable Diesel	biomass based diesel	animal fat, used cooking oil	Uses UOP oil.	Began production in June 2013.
DuPont Cellulosic Ethanol	pilot	Vonore, TN	2010	0.25	0.25	Ethanol	cellulosic	lignocellulosics,corn stover, switchgrass		
DuPont Cellulosic Ethanol	commercial	Nevada, Iowa	2015	0	30	Ethanol	cellulosic	lignocellulosics,corn stover, switchgrass		Facility currently under construction.

Appendix B: Facilities (Low-End)

Company	Facility Type	Facility Location	Projected Online	Anticipated 2014 Capacity	Anticipated 2017 Capacity	Fuel Type	RFS Category	Feedstock	Partnerships	Note
Edeniq & Logos Tech	demo	Visalia, CA	2012	0.05	0.05	Ethanol	cellulosic	corn stover, bagasse	Logos Tech, Novozymes, Ceres, NextStep, USDA and UC Davis	
Emerald Biofuels	commercial	Plaquemine, LA	2016	0	85	Renewable Diesel	biomass based diesel	waste fats and oils	Dow, Honeywell	
Enerkem	demo	Westbury, Quebec	operating	1.3	1.3	Ethanol and methanol	cellulosic	MSW		
Enerkem	commercial	Edmonton, Alberta	2014	0	10	Ethanol and methanol	cellulosic	MSW		Currently producing methanol. Expect to produce ethanol at full capacity in 2016.
Enerkem	commercial	Varennes, Quebec	2017	0	10	Ethanol and methanol	cellulosic	MSW		
Envergent (Honeywell/UOP & Ensyn)	pilot	Kapolei, HI	2014	0	0	Crude oil into renewable diesel and aviation fuel	cellulosic diesel	Ag waste, pulp, paper, wood, energy crops and algae		
Fiberight	commercial	Blairstown, IA	2015	0	6	Ethanol	cellulosic	MSW		Began construction in April, 2014.
Frontrange Energy (Sweetwater)	commercial	Windsor, CO	End-of-year 2016	0	3.5	Ethanol	cellulosic	woody biomass, agricultural residue	Sweetwater Energy	7% of feedstock to come from Sweetwater's cellulosic sugars. In process of acquiring land for Sweetwater facility.
Fulcrum Bioenergy	commercial	Reno, NV	End-of-year 2016	0	10	Jet fuel, diesel	cellulosic diesel	MSW	Waste Management, Waste Connection	
INEOS Bio	commercial	Vero Beach, FL	2013	8	8	Ethanol	cellulosic	Vegetative and yard waste. May incorporate MSW in the future		Suspended production to fix operational issues. Working towards stable production at full capacity.

Appendix B: Facilities (Low-End)

Company	Facility Type	Facility Location	Projected Online	Anticipated 2014 Capacity	Anticipated 2017 Capacity	Fuel Type	RFS Category	Feedstock	Partnerships	Note
Iogen	demo	Ottawa, Ontario	operating (since 2004)	0.48	0.48	Ethanol	cellulosic	Stover, cereal straw, sugarcane bagasse		
Joule	demo	Hobbs, NM	2012	0.11	0.11	Ethanol	cellulosic	CO2 and sunlight	Audi	
LanzaTech	demo	Soperton GA	2015	0	0.125	Ethanol	cellulosic	woody biomass	Virgin Airlines, Siemens	125 tons per day infrastructure in place
Oberon	commercial	Imperial Valley, CA	2013	1.6	60	DME	other	Methanol, methane, biogas, natural gas, stranded gas	Volvo	Diesel replacement for heavy duty vehicles. Volvo Group launching DME fleet.
Pacific Ethanol (Sweetwater Energy)	commercial	Madera, CA	2017	0.00	3.5	Ethanol	cellulosic	Sweetwater sugar	Sweetwater Energy	Will begin permitting process this year.
POET	demo	Scotland, SD	2009	0.02	0.02	Ethanol	cellulosic	Corn stover		
POET- DSM	commercial	Emmetsburg, IA	2014	20	25	Ethanol	cellulosic	Corn stover		Expect to begin cellulosic ethanol production summer 2014.
Quad County Corn	commercial	Galva, IA	2014	1	3.8	Ethanol	cellulosic	corn kernel cellulose		Produced first gallon of cellulosic ethanol in July 2014.
Renewable Energy Group Geismar (Dynamic Fuels)	commercial	Geismar, LA	2010	75	75	Renewable Diesel	biomass based diesel	animal fat, used cooking oil	JV Syntroleum Corp and Tyson	Idle since 2012, but acquired by Renewable Energy Group in 2014.
Renewable Energy Group Life Sciences (formerly LS9)	demo	Okeechobee, FL	operating, 2012	0.07	0.07	Renewable Diesel	cellulosic diesel	Sugar		
Sapphire Energy	commercial	Columbus, NM	operating	1.02	1.02	crude oil	cellulosic diesel	algae	Linde CO2 supplier, Tesoro as customer	Planning 100 barrels of crude oil/day by 2015. Expect to reach commercial scale by 2018.

Appendix B: Facilities (Low-End)

Company	Facility Type	Facility Location	Projected Online	Anticipated 2014 Capacity	Anticipated 2017 Capacity	Fuel Type	RFS Category	Feedstock	Partnerships	Note
Solazyme	commercial	Clinton IA	2013	0	0.13	multiple fuels - renewable	cellulosic diesel	sugar		500,000 L
Solazyme	commercial	Peoria IL	2013	0.53	0.53	multiple fuels - renewable	cellulosic diesel	sugar		2,000,000 L
Virent	demo	Madison, WI	operating	0.01	0.01	renewable fuels and chemicals	cellulosic	beet sugar and other soluble carbohydrates	Shell and Virdia, Scuderia Ferrari	

Summary of Appendix B (Volumes)					
	2013	**2014**	**2015**	**2016**	**2017**
Drop-in	212.635	213.635	213.765	308.765	318.76
Ethanol	11.5	57.5	97.425	114.925	181.925
Other	1.6	1.6	1.6	20	60
Total (Volume)	225.735	272.735	312.79	443.69	560.685

Summary of Appendix B (GGE)					
	2013	**2014**	**2015**	**2016**	**2017**
Drop-in	86.2225	243.5425	243.6907	253.6907	361.985
Ethanol	7.705	38.525	65.27475	76.99975	121.88975
Other (DME, Butanol)	0.96	0.96	0.96	12	36
Total GGE	94.8875	283.0275	309.92545	342.69045	519.87475

Appendix C. Biodiesel Producers

Company	City	State	Capacity (MG)	Note
Advanced Biodiesel	Noblesville	IN	2	
Agribiofuels	Dayton	TX	12	
Allied Renewable Energy	Birmingham	AL	15	
Alternative Fuel Solutions	Huntington	IN	0.8	
American Biodiesel Energy	Erie	PA	4	
Baker Commodities Billerica	Billerica	MA		
Baker Commodities Los Angeles	Vernon	CA		
Beaver Biodiesel	Portland	OR	1	
Bently Biofuels Company	Minden	NV	1	Owned by Pacific Biodiesel
Big Island Biodiesel	Keaau	HI	5	Owned by Pacific Biodiesel
Bio-Alternative	Covington	IN	16	
BIODICO	Multiple		13.0	2 facilities: Denton, TX & Port Hueneme, CA. Formerly Biodiesel Industries
Biodiesel of Las Vegas	Las Vegas	NV	4	
Biodiesel of Texas	Denton	TX	**2**	
BioDiesel One	Southington	CT	3	
BioVantage Fuels	Belvidere	IL	4	
Black Bear Biodiesel	Plainfield	VT		
BlackGold Biofuels	Philadelphia	PA		
Blue Ridge Biofuels	Asheville	NC	1	
Blue Sun Biodiesel	St. Joseph	MO	30	
Bridgeport Biodiesel (Tri-state biodiesel)	Bridgeport	CT	1	Expanding to 8-10 million gallons per year of capacity
Buster Biofuel	San Diego	CA	1.0	CEC award for $2.6M. Plan to scale up capacity to 5 million gallons per year.
Calumet Penreco	Dickinson	TX		
Cape Cod BioFuels	Sandwich	MA	0.5	
Channel Biorefinery & Terminals, LLC	Houston	TX		
Chesapeake Green Fuels	Multiple		12	2 facilities
Clinton County Bio Energy	Clinton	IA	10	
Community Fuels	Stockton	CA	10	American Biodiesel Inc.
Crimson Renewable Energy	Bakersfield	CA	22	Awarded $5M grant from the CEC to expand its biorefinery in Bakersfield.
Delek Renewables AR	Crossett	AR	13	Former Pinnacles facility
Delek Renewables TX	Cleburne	TX	12	Beacon Energy
Double Diamond Biofuels, Inc	Dimmit	TX	30	
Eberle Biodiesel	Liverpool	TX	0.5	
Emergent Green Energy	Minneola	KS	2	
Energy Tec	Maquoketa	IA	0.03	
Eslinger	Dos Palos	CA		CEC award $6M for 5 MG plant in Fresno
Ever Cat Fuels	Isanti	MN	3	
Extreme Biodiesel	Temecula	CA		
Flint Hill Resources LP	Euless	TX		

Appendix C: Biodiesel Producers

Company	City	State	Capacity (MG)	Note
Foothills Bio-Energies	Lenoir	NC	5	
FutureFuel	Batesville	AR	58	
GEN-X Energy Group	Moses Lake	WA	15	Will produce 6 million gallons of biodiesel annually.
General Biodiesel	Seattle	WA	5	
Genuine Bio-Fuel	Indiantown	FL	6	
GeoGreen Biofuels	Vernon	CA		
Global Alternative Fuels	El Paso	TX	15	
Golden Leaf Energy Inc.	Harvey	LA	2	
Grecycle Arizona	Tucson	AZ	2	
Green Biofuels Corporation	Miami	FL		
Green Earth Fuels	Galena Park	TX	90	
Green Energy Products	Sedgwick	KS		Being rebuilt after fire.
Green Gallon Solutions of North America	multiple	FL (3), TN, TX	12.0	5 facilities
Green Waste Solutions of Alaska	Anchorage	AK	0.3	Owned by Pacific Biodiesel
Greenleaf Biofuels	New Haven	CT	10	
Greenwave Biodiesel	Ft. Lauderdale	FL	4	
Griffin Industries	Butler	KY	1.8	Owned by Darling International
HERO BX (Lake Erie Biofuels)	Erie	PA	45	
High Plains Bioenergy	Guymon	OK	30	
Imperial Western Products	Coachella	CA	10.5	
Imperium Renewables	Hoquiam	WA	100	
Iowa Renewable Energy	Washington	IA	30	
Jatrodiesel	Miamisburg	OH	5	
Kelley Green	Goshen	KY	0.1	
Kyoto Fuels Corporation	Lethbridge	AB		
Louisiana ECO Green	Bourg	LA		
Maine Bio-Fuel	Portland	ME	0.5	
ME Bioenergy	Lilbourn	MO	5	
Mesa Processing	Ft. Worth	TX		
Midlands Biofuels	Winnsboro	SC	0	
Midwest Biodiesel Products, LLC	Roxanna	IL	30	
Milligan Bio-Tech	Foam Lake	SK	20	
Mother Earth Energy	Chester	PA		
Natural Biodiesel Plant	Hayti	MO	5	
Nature's Bioreserves	Sioux City	SD		DOD grant 2013
New Leaf Biofuel	San Diego	CA	6	
Newport Biodiesel	Newport	RI	0.5	
Noil Energy Group	Commerce	CA		
North Star Biofuels	Watsonville	CA	20.00	
Northeast Biodiesel	Greenfield	MA		
Oregon Oils, Inc	Portland	OR		
Outpost Biodiesel	Grafton	NH	0.03	
Pacific Biodiesel	Multiple		12	7 facilities not otherwise captured
Patriot Biodiesel	Greensboro	NC	6.9	
Piedmont Biofuels	Pittsboro	NC	3.3	

Appendix C: Biodiesel Producers

Company	City	State	Capacity (MG)	Note
Industrial				
Pleasant Valley Biofuels	Washington City	UT	5.5	
Producers Choice Soy Energy	Moberly	MO	5	
RBF Port Neches, LLC	Port Neches	TX	180	
Red Birch Energy, Inc.	Bassett	VA	3	
Renewable Energy Group	Multiple		257	8 facilities. 4 additional facilities in development
REV Biodiesel	Gilbert	AZ	10	Division of Pure Earth Energy Resources.
Sabine Biofuels II	Port Arthur	TX	30	Joint venture of Endicott Biofuels and Holly Corporation
Sanimax Energy	Deforest	WI	20	
Scott Petroleum Corporation	Greenville	MS	20	
SeQuential	Salem	OR	5.0	Owned by Pacific Biodiesel
Shenandoah Agricultural Products	Clearbrook	VA	0.3	
Simple Fuels Biodiesel, Inc.	Chilcoot	CA	1	
Smart Fuels Florida	Fruitland Park	FL	3	
Southeast BioDiesel	North Charleston	SC	5	
Southeastern Biodiesel Solutions	Creola	AL	1	
Sullens Biodiesel	Morrison	TN	2	
Sun Power Biodiesel	Cumberland	WI	3	
Texas Biotech, Inc	Arlington	TX	5	
Texas Green Manufacturing	Littlefield	TX	1.3	
The La Grange Plant	La Grange	TX	3.5	
Thumb BioEnergy	Sandusky	MI	0.4	
Tidewater Biodiesel	Chesapeake	VA		
TMT Biofuels	Port Leyden	NY	0.3	
Triangle Biofuels Industries	Wilson	NC	3	
United Oil Company	Pittsburgh	PA	5	
US Alternative Fuels Corp.	Johnstown	PA	2	
Vanguard Synfuels	Pollock	LA	12	
Veros Energy	Moundville	AL	37	
Viesel Fuel	Stuart	FL	11	
Virginia Biodiesel Refinery	West Point	VA	7	Owned by Pacific Biodiesel
W2Fuel LLC	Multiple	IA & MI	20.0	2 facilities
Walsh Bio Fuels	Mauston	WI	5	
Washakie Renewable Energy	Plymouth	UT	10	
Western Dubuque Biodiesel	Farley	IA	36	
Western Iowa Energy	Wall Lake	IA	30	
White Mountain Biodiesel	North Haverhill	NH	5.5	
Whole Energy Fuels	Anacortes	WA	2	
Wil Fischer Distributing Co.	Springfield	MO		
World Energy (US Biofuels)	Rome	GA	13	

Appendix C: Biodiesel Producers

Total Capacity (Million Gallons/Year)	1,545.0
Number of Companies	123

E2's biodiesel list includes active biodiesel producers that process non-virgin feedstocks or can accept non-virgin feedstocks. We do not include facilities that process virgin oils only, although it is possible that these facilities will make modifications to their facilities to accept other feedstocks in the future. Capacity included virgin oil facilities totals 2.4 billion gallons per year.

Appendix D. Feedstock Producers

Company	City	State	Type	Partnerships	Note
Agrisoma	Ottawa	Ontario	Feedstock producer	Agriculture and Agri-Food Canada, BioDimensions, Genome Prairie, POS BioSciences, Sustainable Development Technology Canada	carinata
Algae.Tec	Atlanta	GA	Feedstock Producer		algae producer
AlgaeVenture Systems	Marysville	OH	Feedstock producer		Algae producer
Aloterra	The Woodlands	TX	feedstock producer		Vertically integrated miscanthus project developer. Works with farmers to develop unusable land.
ArborGen	Ridgeville	SC	Feedstock producer		Tree seedling provider
Arcadia Biosciences	Davis	CA	feedstock producer	FuturaGene, DuPont	Eucalyptus and poplar trees using nitrogen use efficiency and water use efficiency technologies.
Arvens Technology, Inc., a Pennycress Energy Company	Peoria	IL	feedstock Producer		pennycress seeds as a feedstock
Aurora Algae	Hayward	CA	Feedstock producer		Algae producer
BARD	Morrisville	PA	Feedstock producer		Algae producer
BioProcess Algae	Portsmouth	RI	feedstock producer		Algae bioreactors and production. Colocated five acre facility at Green Plains ethanol plant in Iowa.
Cellana	San Diego	CA	Feedstock producer		Algae producer. Signed offtake agreement to provide algal oil to Neste in June 2013. Signed LOI with Galil Algae Cooperative in June 2014 to scale algae 33razili with high commercial value
Ceres	Thousand Oaks	CA	Feedstock producer	Syngenta	Several energy crops
Chromatin	Chicago	IL	Feedstock producer	POET, Calgren, Aemetis, Pacific Ethanol	Sorghum development and production
Comet Biorefining	London	Ontario	Sugar Refiner		
Enviva	Bethesda	MD	Feedstock Producer		wood pellets, facilities in several states, exports to Europe.
Fermentalg			Microalgae		Technology that breeds microalgae using byproducts of food and chemical industries.

Appendix D: Feedstock Producers

Company	City	State	Type	Partnerships	Note
Florida Crystals Corp	West Palm Beach	FL	Sugar Refiner		
Global Clean Energy Holdings	Long Beach	CA	feedstock producer		Camelina and jatropha producer. RSB Certified. Acquired Sustainable Oils in 2013.
Kent Bioenergy	San Diego	CA	Feedstock producer		Algae producer
Matrix Genetics	Seattle	WA	feedstock producer		algae producer
Mendota Advanced Bioenergy Beet Cooperative	Fresno	CA	Feedstock producer		Sugar beets
Naturally Scientific (INTERNATIONAL)	Nottingham	UK	Sugar Refiner	Sweetwater Energy	Sugar and PVO production
NexSteppe	South San Francisco	CA	Feedstock producer	DuPont	Sorghum and switchgrass production
PacificAg (formerly Pacific Powerstock)	Boardman	OR	Feedstock producer	Edeniq	biomass- energy harvest pellets
Proterro	Ewing	NJ	Feedstock producer & technology		Sucrose production and photobioreactor system
Purevision Technology	Fort Lupton	CO	feedstock producer		sugar and lignin from non-food biomass
Renewed World Energies	Georgetown	SC	Feedstock producer	US Fuel Ventures, Emerald Biofuels	Algae producer
Renmatix	Kennesaw	GA	Sugar Refiner	BASF, Waste Management	Sugar production from biomass
SG Biofuels	Encinitas	CA	Feedstock Producer	Jetbio, Airbus SAS; Fiagril	jatropha
Solix	Fort Collins	CO	Feedstock producer		Algae production and extraction
Sweetwater Energy	Rochester	NY	Sugar Refiner	Pacific Ethanol, Naturally Scientific, Front Range Energy, Ace Ethanol	Sugar from non-food sources
TerViva	Oakland	CA	Feedstock producer	Mason & Morse Farmland Group	renewable tree oil
Virdia (former HCL Cleantech)	Redwood City	CA	Sugar Refiner	Virent, LS9	Working with Virent on aviation fuels project & plans for MS commercial facility.
Xylowatt (INTERNATIONAL)		Belgium	Feedstock producer		Syngas
Yulex Corporation	Phoenix	AZ	Feedstock producer	University of Arizona, Gila River Indian Company	Syngas from guayule

Appendix E. Enzyme/Chemical Producers

Company	City	State	Type	Partnerships	External note
AgriVida	Cambridge	MA	Enzymes	POET	Inzyme™ technology
Albemarle	Baton Rouge	LA	Catalysts	Neste, Velocys	acquired Catilin in 2011
CRI Catalyst Co	Houston	TX	catalysts	Shell, KBR	IH2 technology
DuPont & Genencor	Wilmington	DE	Enzymes/Chemicals	Butamax	Seeds, Fermasure, Enzymes
Dyadic	Jupiter	FL	Enzymes	Abengoa, BASF, Codexis	Genomic research and enzymes
Kiverdi	Berkeley	CA	Chemicals and catalysts		Fuel additives
Mascoma	Waltham	MA	Enzymes		Proprietary yeasts and microbes
Metabolix	Cambridge	MA	Chemicals		Performance additives
Microvi	Hayward	CA	Enzymes and catalysts	Aquatech International	
Midori Renewables	Cambridge	MA	catalysts		Melts cellulosic biomass into sugars
NextCAT	Detroit	MI	Catalysts		For biodiesel production
Novozymes	Davis	CA	Enzymes	Fiberight, POET, Lignol, Ceres, ICM, Beta Renewables	

Appendix F. Related Technology Companies

Company	City	State	Type	Partnerships	Note
Agradis	La Jolla	CA	Plant genomics	Synthetic Genomics	Sorghum and castor genetics. Monsanto purchased selected assets Feb 2013.
Agrisoma Biosciences	Ottawa	Ontario	plant genomics	PGF Biofuels, USDA, others	Brassica carinata research. Agricultural yield improvement technology
Algenetix	San Diego	CA	Plant genomics		Incubated by Kapyon Ventures, Algenetix is bioengineering feedstocks.
Arisdyne Systems	Cleveland	OH	Equipment and Technology		Hydrodynamic cavitation, retrofit equipment for ethanol and biodiesel producers.
Avello	Boone	IA	Feedstock conversion	Borregaard, Cargill	Pyrolysis separation technology
Benefuel	Irving	TX	Technology	Koch Industries, Sud Chemie	Announced first commercial application of its technology through JV with Flint Hills Resources, a 50mm gallon plant in Wichita set for Summer 2015 production.
Biocee	Minneapolis	MN	Equipment and Technology	Verenium	Biocatalytic reactor
Biodico	Santa Barbara	CA	Equipment	Navy	Construction/operation biorefineries. US Naval Base, Ventura County.
BioTork	Gainesville	FL	technology		Biocatalyst engineering for improved fermentation performance
Blendstar	Omaha	NE	Distribution		Renewable fuel terminals
Carbo Analystics	Fort Collins	CO	Sugar analytics		SBIR grant from DOE with CEM
Chemtex	Wilmington	NC	Technology	COFCO, Beta Renewables, Codexis, Canergy	Biomass processing technology. Conversion of corn ethanol facilities to cellulose. Technology partner of Canergy for their 30mm gallon plant progressing in California.
Dogpatch Biofuels	San Francisco	CA	Distribution & Marketing		San Francisco fueling center
Eco-Energy	Franklin	TN	Distribution & Marketing		Ethanol distribution; located throughout corn belt
Fluor	Irving	TX	Engineering & construction		Performs engineering services for multiple biofuel customers, such as Joule and LS9.
Foster Wheeler	Houston	TX	Engineering & construction	NSE Biofuels	
Harris Group	Seattle	WA	Engineering Consulting		Multi-disciplinary engineering firm with longstanding history of consulting biorefineries
ICM	Colwich	KS	Technology, equipment and construction	Abengoa Bioenergy, IGPC Ethanol	Equipment and tech used in the majority of ethanol facilities, Fiber Separation Technology

Appendix F: Related Technology

Company	City	State	Type	Partnerships	Note
Imperative Energy			Equipment		Biomass boiler system and fuel handling equipment
Intrexon	Boston	MA	Microbe engineering		S-1 filed. Engineering metabolic pathways.
Inventure	Tuscaloosa	AL	Technology	General Atomics, UOP Honeywell, SG Biofuels	Converting biomass into mixed industrial sugars.
KBR	Houston	TX	Engineering & construction		Offers technology development, plant scale-up, engineering, procurement, construction, operation, and maintenance services for Renewable and Biomass based facilities
Lallemand	Milwaukee	WI	Yeasts	Mascoma	Yeast and bacteria supplier
Linde Group	Munich	Germany	Technology	Sapphire, Siluria	Gas and engineering group. Providing gases and hydrotreating capacity.
Marrone Bio Innovations	Davis	CA	Bioincesctici de		Recipient of USDA Agriculture Business and Industry Group $10M loan guarantee
Mendel Biotechnology	Hayward	CA	Plant genomics	DuPont, Bayer CropScience, Monsanto	Plant gene regulatory networks
Metabolix	Cambridge	MA	Plant genomics		Crop technology related to polyhydroxybutarates
Methes Energies	Las Vegas	NV	Equipment		Biodiesel processing units, multi-disciplinary services for biodiesel producers
MicroBio Engineering	San Luis Obispo	CA	Engineering & tech development		engineering services and technology development in microalgae production
Nexterra	Vancouver	BC	Gasification Technology	GE, UBC, ORNL	Biomass gasification. Oak Ridge National Lab plant facility
Novogy	Cambridge	MA	Yeasts	Total	Yeast biocatalyst. Previously pursuing waste paper to ethanol process
OpenAlgae	Austin	TX	Technology		Mobile algae extraction unit
Propel Fuels	Redwood City	CA	Distribution		Leases, owns and operates biofuel stations on West Coast
ProTec Fuel Management	Boca Raton	FL	Distribution		Ethanol marketing and distribution
SkyNRG	Amsterdam	Netherlands	Demand aggregation		RSB certified
Sylvatex	San Francisco	CA	Additive		Additive to ethanol or diesel
SynGest	San Francisco	CA	Additive		Urea production as a fuel additive
Synthetic Genomics	San Diego	CA	Plant genomics	ExxonMobil	Exxon's main biofuel investment. Monsanto made equity investment

Appendix F: Related Technology

Company	City	State	Type	Partnerships	Note
Tenaska Energy	Omaha	NE	Equipment & Marketing		Natural gas-fueled generation plants and biofuel marketing + distribution
TetraTech	Pasadena	CA	Engineering & tech development		Range of services, including feasibility studies, cost estimates, licensing, and engineering
ThermoChem Recovery International (TRI)	Baltimore	MD	Gasification Technology		
Velocys	Plain City	OH	Technology	Solena Fuels	JV with Waste Management, NRG on GTL from renewable biogas and natural gas
Verdezyne	Carlsbad	CA	Technology licensor	Lallemand	Enzymatic hydrolysis technology, yeast and microorganism development. Also producing chemicals
XF Technologies (formerly Incitor)	Albuquerque	NM	Additive		Additive can be made from diverse biomass feedstock and blended with gasoline or diesel. Meets many mandates when derived from cellulosic biomass
Zarco 66	Lawrence	KS	Distribution & Marketing		Seven biofuel gas stations across Kansas
ZeaKal	San Diego	CA	plant genomics		Bioengineering feedstocks

Appendix G. International Companies

Company	Headquarters	Plant Location(s)	Fuel Type	Feedstock	Notes
Abengoa	Spain	Salamanca	Ethanol	Municipal Solid Waste, agricultural residues	In addition to its U.S. cellulosic project in Kansas, Abengoa has completed a demonstration unit in Salamanca, Spain.
Algae.Tec	Australia, US	Australia, Sri Lanka, Germany, US	biodiesel, jet fuel	algae	Produces algal oil and partners with refineries to produce a variety of renewable fuel products. Australian/US based company with projects in Australia, the US, Sri Lanka, Germany, and – as of 2014 – India. Sri Lanka facility will eventually produce 31 million litres of oil for biofuel production.
Amyris	US, Brazil	Sao Paulo and Usina, Brazil	Diesel; Jet Fuel	Sugar Cane	Operates pilot and demonstration facilities and is building a commercial scale production facility in San Martino, Brazil. Furthermore, Amyris is partnering with Total on alternative aviation jet fuel to be sold in US, European and Brazilian markets. Brazil's GOL Airlines begins the first commercial flight using up to 10% renewable fuel on its Boeing 737 flights between the US and Brazil in July 2014.
Beta Renewables	Italy	Crescentino, Italy	Ethanol	Wheat Straw	Beta Renewables is a $350 million joint venture between Chemtex and TPG. The company began shipping fuel from its Crescentino facility in June 2013 and is building a facility in North Carolina, in addition to several technology licenses.
Borregaard	Norway	Sarpsborg, Norway	Ethanol	Woody Biomass	Borregaard produces advanced 39razilian39l, biomaterials and bioethanol that can replace oil-based products. Its ethanol plant in Norway has a capacity of 17-19 million liters. The company works throughout Europe, Asia, and Africa, and has several biochemical projects based in the United States. In 2014, Borregaard was awarded $5M in grants from Innovation Norway and the Research Council of Norway for continued work on biomass research.
BP Biofuels – Butamax	Wilmington, DE	Hull, UK	biobutanal	sugarcane, lignocellulosic	Plan to retrofit ethanol facilities to produce biobutanol. Legal challenge from Gevo over patent infringement still pending at time of publication.
Bunge	Bermuda (HQ in US)	Sao Paulo and Minas Gerais, Brazil (8 plants)	Ethanol (*markets biodiesel)	Sugar Cane (ethanol);	Bunge operates eight sugarcane mills in Brazil with a combined capacity of 1.1 million cubic meters per year. Bunge also participates in the biodiesel industry, normally as a minority investor in facilities in Argentina, the US and Europe.
Celtic Renewables	Edinburgh, Scotland	Ghent, Belgium	biobutanol	Draff (barley byproduct of whiskey making)	Recently funded to pilot commercialization of their biobutanol made from whiskey byproducts.
COFCO/Sinopec	China	Zhaodong, China	ethanol	agricultural residue	50,000 MT/year capacity. Expected online this year; no recent news. Novozymes as partner

Appendix G: International Companies

Company	Headquarters	Plant Location(s)	Fuel Type	Feedstock	Notes
Clariant	Germany	Munich, Germany; Straubing, Germany	ethanol	agricultural residue	Clariant runs both a pilot and demonstration facility in Germany, and has an annual capacity of 1,000 tons of ethanol/year. In the midst of a 12-month field test of their sunliquid cellulosic ethanol, partnering with Mercedes-Benz and Haltermann.
Shell (Raízen project)	The Netherlands	Sao Paulo State, Brazil	ethanol	sugarcane	Raízen is a joint venture between Shell and Cosan, a 40razilian energy company. With 24 mills, it will produce 2 billion liters a year of sugarcane ethanol, with plans to expand into biofuels from agricultural residue.
EdeniQ	US	Sao Paulo State, Brazil	ethanol	sugarcane	EdeniQ has partnered with Brazilian company Usina Vale to build a cellulosic ethanol demonstration plant at Usina Vale's sugarmill. This project is still in the development
Eni	Italy	Venice, Italy	green diesel/biodiesel	Phase 1: Palm oil, Phase 2: Waste oils, possibly MSW and algae	Eni is in the process of converting a traditional refinery to a biorefinery in Venice, in partnership with UOP. The plant will begin producing green diesel in 2014 and be fully operational by 2015.
Ensyn	Wilmington, DE	Brazil, Ontario Canada	Renewable gasoline & diesel	Biomass	Converted Renfrew (Ontario) plant set to open in 2014, with capacity of 3M gallons/year and orders already taken in the US. Signed agreement in October, 2012 with Fibria to produce cellulosic biofuel in Brazil. Feedstock procured, assessing financing and equipment. Rapid thermal processing.
GranBio (formerly GraalBio)	Brazil	Alagoas, Brazil	Ethanol	sugars	Using Beta Renewables Proesa technology at its Alagoas facility, which began operating in September 2014. GranBio has also partnered with American Process, Inc. to use its technology in new facilities in Brazil and the United States.
Green Biologics	United Kingdom		Biobutanol	lignocellulosic biomass	In addition to its pilot facility in Columbus, OH, Green Biologics has established offices in India, China, and Brazil, and is exploring commercial opportunities in these countries. In late 2013, it signed a letter of intent to acquire the assets of Central MN Ethanol Co-op. Closed a $25M Series B in December 2013, plans to enter US market fully in 2016.
Inbicon/DONG	Denmark	Kalundborg, Denmark	Ethanol	Wheat Straw	The Maabjerg Energy Concept plant in Denmark received an EU performance guarantee in July 2014 worth $52M. Currently also operates a large scale pilot plant in Denmark. It has formed several strategic partnerships to develop new projects in Denmark, China, and North America.
LanzaTech	US	China (Bejing and Shanghai)	Ethanol	Flue gas	Series D funding of $60M in March 2014 to extend LanzaTech's gas fermentation platform and technology worldwide. In addition to its U.S. project in Soperton, GA, LanzaTech has three demonstration facilties in China and Taiwan using flue gas. Chinese commercial facility in design.

Appendix G: International Companies

Company	Headquarters	Plant Location(s)	Fuel Type	Feedstock	Notes
NAM Petroleum	South Africa	South Africa	ethanol	non-virgin oils, non-food biomass	Received seed money from SAB plus a year of mentoring. Uses non-virgin oils and non-food feedstocks.
Neste Oil	Finland	Singapore; Netherlands; Finland	renewable diesel; jet fuel	vegetable oils, waste residues	Renewable diesel refineries in Singapore, the Netherlands, and Finland. Importing to U.S. Entered into an offtake agreement in California with Cellana.
Petrobras	Brazil	Candeias, Quixadá and Montes Claros	Ethanol; Biodiesel	Multi Feedstock biodiesel); Sugar cane (ethanol)	Three biodiesel plants in Brazil with total production capacity of 170,000 cubic meters (46M gallons) per year. Including the plants they partner with, their biodiesel capacity grows to 216M gallons/year. Through stake in 10 plants throughout Brazil, they have a production capacity of 396M gallons/year.
PGF Biofuels	Manitoba, Canada			Oil seeds (carinata)	PGF Biofuels produces and markets carinata for the global oilseed industry. It is a subsidiary of Paterson Global Foods Inc.
Praj Industries	India	India, Malawi, Thailand, Louisiana, El Salvador, Sri Lanka	Biodiesel, Ethanol	Sugarcane (juice/molasses), beet, grains (wheat, corn, sorghum, broken rice, and triticale), tubers	Demo facility capable of 1.3M gallons of ethanol/year, set to come online at the end of 2014. It also expects to build a similarly-sized demo plant outside of India soon. Meanwhile, it will also pursue cost-efficient bolt-on facilities.
Sapphire / Sinopec		China or Mongolia	unknown	unknown	Won the EcoPartnership, a US-China award to create crude oil from algae in China.
SkyNRG	The Netherlands		jet fuel	Vegetable oils, waste oils, greases. Exploring paper/pulp and claims to be “agnostic” overall.	SkyNRG has teamed with Statoil to develop regional supply chains for sustainable jet fuel. Recently, BMI began the first commercial flights using biofuel out of the Karlstad (Sweden) airport in Sweden.
Solazyme Bunge	Brazil	Moema, Brazil	Biodiesel, renewable diesel, jet	Sugarcane, algae	Production at the Brazil plant, capable of 318M gallons (100,000 MT) per year of renewable oils. Co-located with Bunge sugarcane mill, and $120M loan from BNDES.
Solena	Washington, DC	UK, Germany, Australia	jet fuel, biodiesel	MSW, agricultural residue, woody biomass	Partnerships with British Airways, Lufthansa, and Qantas, including offtake agreements. Building a 16 MGY facility in England, set for completion in 2017
Statoil	Norway	Mestilla, Lithuania	Biodiesel	Rapeseed, cereals, sugar cane, algae (R&D)	Mestilla plant: annual capacity of 100,000 tonnes. Ethanol at 1300 stations in six countries – Norway, Sweden, Denmark, Lithuania, Latvia and Poland.
Sunbird Energy	Australia	Nigeria	Ethanol	Cassava	Signed an MOU with China New Energy for the first of up to 10 cassava-based ethanol plants. 29M gal/year is the projected capacity of the $24M plant.

Appendix H. Public Finance

Company	Date	Amount	Finance Type	Public Entity
Abengoa Bioenergy	08/19/11	$133,900,000	Loan Guarantee	U.S. Department of Energy
Abengoa Bioenergy	05/12/05	$2,250,000	Grant	U.S. Department of Energy
Aemetis	06/14/12	$1,875,528	Grant	California Energy Commission
Agrivida	11/20/09	$2,000,000	Grant	U.S. Department of Agriculture
Agrivida	07/01/07	$149,500	Grant	National Science Foundation
Agrivida	10/26/09	$4,565,800	Grant	U.S. Department of Energy
Algaeventure Systems	02/02/11	$1,500,000	Loan	State of Ohio
Algaeventure Systems	10/27/10	$5,900,000	Grant	U.S. Department of Energy
Algenol Biofuels	12/04/09	$25,000,000	Grant	U.S. Department of Energy
American Process Inc	02/01/10	$18,000,000	Grant	U.S. Department of Energy
American Process Inc	06/01/10	$4,000,000	Grant	Michigan Center of Energy Excellence
Archer Daniels Midland	06/01/10	$24,800,000	Grant	U.S. Department of Energy
Arvens Technology	01/01/10	$90,000	Grant	U.S. Department of Agriculture
Arvens Technology	01/01/11	$460,000	Grant	U.S. Department of Agriculture
Aurora Algae	09/28/12	$2,000,000	Grant	Government of Australia
Bently Biofuels	05/15/13	$17,362	Grant	U.S. Department of Agriculture
Bently Biofuels	07/27/12	$3,479	Grant	U.S. Department of Agriculture
Bently Biofuels	03/12/10	$2,144	Grant	U.S. Department of Agriculture
Bently Biofuels	10/31/11	$18,864	Grant	U.S. Department of Agriculture
Bently Biofuels	01/24/11	$5,876	Grant	U.S. Department of Agriculture
BioCee	10/26/09	$2,200,000	Grant	U.S. Department of Energy
Biodico	04/11/12	$2,000,000	Grant	California Energy Commission
Biodiesel of Las Vegas	05/15/13	$5,400	Grant	U.S. Department of Agriculture
BioProcess Algae (Elevance partnership)	04/22/13	$6,400,000	Grant	U.S. Department of Energy
BlueFire Renewables	12/31/09	$88,000,000	Grant	U.S. Department of Energy
Buster Biofuels	03/20/13	$2,641,723	Grant	California Energy Commission
Carbo Analytics	05/09/13	$150,000	Grant	U.S. Department of Energy
Cellana	07/17/14	$3,500,000	Grant	U.S. Department of Energy
Cellana	05/06/11	$5,521,173	Grant	U.S. Department of Agriculture
Chemtex	08/23/12	$99,000,000	Loan Guarantee	U.S. Department of Agriculture
Cobalt Technologies	04/19/11	$18,000,000	Grant	U.S. Department of Energy
Cobalt Technologies	04/22/13	$2,500,000	Grant	U.S. Department of Energy
Community Fuels	07/30/12	$426,878	Grant	U.S. Department of Agriculture
Community Fuels	12/26/13	$4,904,375	Grant	California Energy Commission
Cool Planet Energy Systems	11/08/13	$10,000,000	Grant	U.S. Department of Agriculture
Cool Planet Energy	10/06/14	$91,000,000	Loan	U.S. Department of Agriculture

Company	Date	Amount	Finance Type	Public Entity
Systems			Guarantee	
Crimson Renewable Energy	12/19/13	$5,000,000	Grant	California Energy Commission
EdeniQ	06/14/12	$3,900,000	Grant	California Energy Commission
EdeniQ	03/24/11	$20,500,000	Grant	U.S. Department of Energy
Emerald	09/19/14	$70,000,000	Grant	U.S. Department of Defense
Emerald Biofuels	05/28/13	$5,650,000	Grant	U.S. Department of Energy
Enerkem	01/21/11	$80,000,000	Loan Guarantee	U.S. Department of Agriculture
Enerkem	12/31/10	$50,000,000	Grant	U.S. Department of Energy
Eslinger Biodiesel	02/12/13	$6,000,000	Project Finance	California Energy Commission
Fiberight	01/23/12	$25,000,000	Loan Guarantee	U.S. Department of Agriculture
Fiberight	12/31/10	$2,500,000	Grant	State of Iowa
Fulcrum Bioenergy	09/19/14	$70,000,000	Grant	U.S. Department of Defense
Fulcrum Bioenergy	08/08/12	$105,000,000	Loan Guarantee	U.S. Department of Agriculture
Fulcrum Bioenergy	05/24/13	$4,700,000	Grant	U.S. Department of Defense
Gevo	09/28/11	$5,000,000	Grant	U.S. Department of Agriculture
Haldor Topsoe	12/29/09	$25,000,000	Grant	U.S. Department of Energy
Hawaii Bioenergy	08/02/13	$5,000,000	Grant	U.S. Department of Energy
INEOS New Planet BioEnergy	08/19/11	$75,000,000	Loan Guarantee	U.S. Department of Agriculture
INEOS New Planet BioEnergy	12/04/09	$50,000,000	Grant	U.S. Department of Energy
Iogen	02/08/07	$80,000,000	Project Finance	U.S. Department of Energy
Kiverdi	09/05/12	$747,126	Grant	California Energy Commission
LanzaTech	11/19/10	$500,000	Project Finance	U.S. Department of Energy
LanzaTech	08/31/11	$4,000,000	Grant	U.S. Department of Energy
LanzaTech	06/22/11	$500,000	Grant	Defense Advanced Research Projects Agency (DARPA)
Logos Technologies	03/24/11	$20,500,000	Grant	U.S. Department of Energy
Mercurius Biofuels	04/22/13	$4,600,000	Grant	U.S. Department of Energy
Metabolix	05/16/12	$6,000,000	Grant	U.S. Department of Energy
Nature's BioReserves	05/24/13	$6,000,000	Grant	U.S. Department of Defense
NextCAT	08/29/11	$500,000	Grant	National Science Foundation
Oberon Fuels	06/07/13	$500,000	Grant	San Joaquin Valley Air Pollution Control District
OPXBIO	08/30/10	$6,000,000	Grant	U.S. Department of Energy
Pennycress Energy Company	10/24/11		Grant	U.S. Department of Agriculture
Pennycress Energy Company	09/30/10		Grant	U.S. Department of Agriculture
Phycal	07/23/10	$24,243,509	Grant	U.S. Department of Energy

Company	Date	Amount	Finance Type	Public Entity
Phycal	05/08/13	$27,200,000	Grant	U.S. Department of Energy
Propel Fuels	06/01/12	$10,100,000	Grant	California Energy Commission
Red Rock Biofuels	09/19/14	$70,000,000	Grant	U.S. Department of Defense
Red Rock Biofuels	06/21/13	$4,100,000	Grant	U.S. Department of Defense
Sapphire Energy	11/09/11	$135,000,000	Loan Guarantee	U.S. Department of Agriculture
Sapphire Energy	12/07/09	$54,500,000	Loan Guarantee	U.S. Department of Agriculture
Sapphire Energy	12/31/09	$50,000,000	Grant	U.S. Department of Energy
Sapphire Energy	08/02/13	$5,000,000	Grant	U.S. Department of Energy
Sierra Energy	08/06/12	$5,000,000	Grant	California Energy Commission
Solazyme	04/08/09	$800,000	Grant	California Energy Commission
Solazyme	01/10/11	$1,500,000	Grant	California Energy Commission
Sweetwater Energy	12/20/13	$2,500,000	Grant	New York State Energy Research and Development Authority
Synthezyme	01/11/10	$150,000	Grant	National Science Foundation
Synthezyme	05/17/11	$475,000	Grant	National Science Foundation
UOP	03/03/10	$1,500,000	Grant	U.S. Department of Energy
UOP	12/02/11	$1,100,000	Grant	Federal Aviation Administration
Velocys (Original Company)	12/02/11	$1,500,000	Grant	Federal Aviation Administration
Verenium	07/14/08		Grant	U.S. Department of Energy
Verenium	02/27/08		Grant	U.S. Department of Energy
Verenium	04/22/10	$4,900,000	Grant	U.S. Department of Energy
Virdia	03/06/12	$75,000,000	Structured Debt	Mississippi Development Authority
Virdia	06/10/11	$9,000,000	Grant	U.S. Department of Energy
Virent Energy Systems	08/31/11	$4,000,000	Grant	U.S. Department of Energy
Virent Energy Systems	06/13/11	$13,400,000	Grant	U.S. Department of Energy
Virent Energy Systems	02/28/07	$2,000,000	Grant	U.S. Department of Agriculture
Virent Energy Systems	07/01/13	$4,000,000	Grant	U.S. Department of Energy
Virent Energy Systems	12/02/11	$1,500,000	Grant	Federal Aviation Administration

Grants	$847,953,737
Loan Guarantees	$707,400,000
Total Public	$1,793,353,737