SCALING ENTERPRISE FINANCE

The Future of Biofuels

MILKEN INSTITUTE

APRIL 2010

Financial Innovations Labs™ bring together researchers, policymakers, and business, financial, and professional practitioners for a series of meetings to create market-based solutions to business and public-policy challenges. Using real and simulated case studies, participants consider and design alternative capital structures and then apply appropriate financial technologies to them.

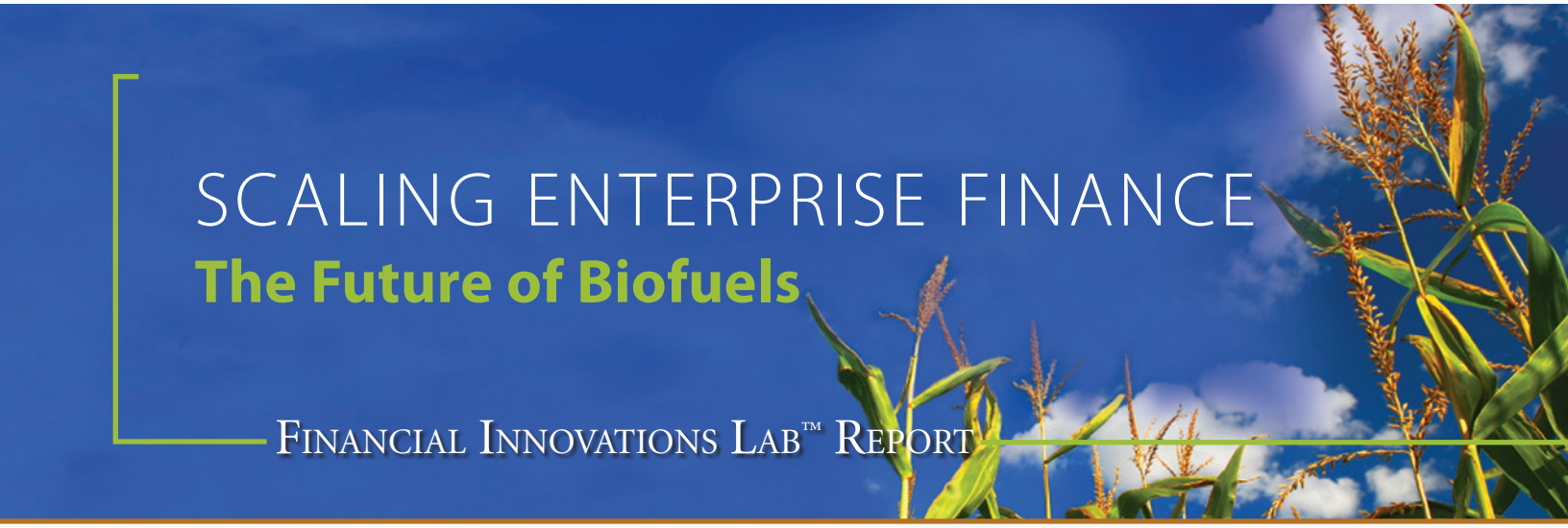
This Financial Innovations Lab™ Report was prepared by Joel Kurtzman, Tong Li, James Barth, and Brian Vo.

April 2010

Milken Institute

SCALING ENTERPRISE FINANCE

The Future of Biofuels



Financial Innovations Lab™ Report

Acknowledgments

This project received financial support from the Office of Energy Policy and New Uses, U.S. Department of Agriculture. We especially thank Drs. Roger Conway and Marvin Duncan of the Office of Energy Policy and New Uses for their invaluable assistance on this important project.

Finally, we would like to thank our Milken Institute colleagues Caitlin MacLean, who helped organize the Lab, executive assistants Karen Giles and Cheryl Murphy, editor Lisa Renaud, and the Creative Services team for their tremendous effort.

The Milken Institute is an independent economic think tank whose mission is to improve the lives and economic conditions of diverse populations in the United States and around the world by helping business and public policy leaders identify and implement innovative ideas for creating broad-based prosperity. We put research to work with the goal of revitalizing regions and finding new ways to generate capital for people with original ideas.

We focus on:

human capital: the talent, knowledge, and experience of people, and their value to organizations, economies, and society;
financial capital: innovations that allocate financial resources efficiently, especially to those who ordinarily would not have access to them, but who can best use them to build companies, create jobs, accelerate life-saving medical research, and solve long-standing social and economic problems; and
social capital: the bonds of society that underlie economic advancement, including schools, health care, cultural institutions, and government services.

By creating ways to spread the benefits of human, financial, and social capital to as many people as possible—by *democratizing* capital—we hope to contribute to prosperity and freedom in all corners of the globe.

We are nonprofit, nonpartisan, and publicly supported.

Table of Contents

Government spending alone cannot accomplish a task of this magnitude. How can we facilitate the flow of private capital into the production of biofuels?

Introduction

America is finally coming to grips with the need to minimize its dependence on imported oil. Faced with a host of geopolitical risks and the looming threat of climate change, policymakers are taking a hard look at ways to diversify the nation's energy portfolio.

In the last few years, biofuels—that is, energy-dense liquid fuels made from plants and other organic matter—have enjoyed a significant momentum, both at home and abroad. Today, most cars and SUVs in the United States are capable of running on gasoline blended with 10 percent ethanol, and multiple airlines have conducted successful tests of bio-jet-fuel blends.[1] Major oil companies have announced multi-million-dollar plans to invest in biofuel ventures and research. Global revenue of ethanol and biodiesel production reached $34.8 billion in 2008 and is expected to triple by 2018.[2] A bit of comparison will put this growth in perspective, however: This 2008 figure represents just 2 percent of the $1.76 trillion in revenues generated by the top five oil companies in the world.

The United States has seen oil imports worsen an already gaping trade deficit. Against this backdrop, biofuels hold tremendous appeal as an energy source that could be produced domestically. The development of a flourishing biofuels industry would generate jobs and open the door to major opportunities for the U.S. agricultural sector.

Despite their promise, biofuels must overcome considerable hurdles. Scientists, policymakers, and activists continue to debate the pros and cons of these fuels. Further process and technology refinements are needed to ensure that biofuels make a significant dent in carbon emissions while avoiding other negative environmental impacts.

Building a robust, large-scale biofuels industry is no small task. Beyond the extensive R&D effort required, it will also be necessary to build a network of cutting-edge processing plants and to open up nationwide distribution and retail channels. Taking this idea to scale will call for a vast infusion of capital.

Achieving a major shift in the mix of energy sources used by the United States requires government support to set things in motion. The federal government has already put a variety of mechanisms into place, from tax credits to direct grants. On December 4, 2009, U.S. Energy Secretary Steven Chu and Agriculture Secretary Tom Vilsack announced that nineteen biorefineries would receive $564 million in funding from the American Recovery and Reinvestment Act (ARRA). In addition to receiving a $50 million grant from the Department of Energy (DOE) as part of this ARRA funding, Sapphire Energy also received a $54.5 million loan guarantee under the USDA's Biorefinery Assistance Program for developing a process that will transform algae into jet fuels and diesel. These public programs are to be matched with more than $700 million in private and non-federal cost-share funds, for total project investments of almost $1.3 billion.[3]

The effort to leverage private matching funds in the investments described above underlines a crucial point: Government spending alone cannot accomplish a task of this magnitude. Federal programs can help lead the way, but policymakers must find strategies for bringing more private investors with additional funds to the table.

How can we facilitate the flow of private capital into the production of biofuels? To answer that question, a Financial Innovations Lab, jointly developed and funded by the Milken Institute and the Office of Energy Policy and New Uses at the U.S. Department of Agriculture, was convened in Washington, D.C. This event gathered leading scientists and technologists, biofuel producers, rural stakeholders, banks, institutional investors, venture capitalists, public officials, and representatives from think tanks and clean-tech industry associations. Together they identified practical solutions that can encourage investment and help this fledgling industry grow to maturity, building a greener economy in the process.

Building on Success: Three Generations of Biofuels

For the sake of convenience, many industry observers refer to three "generations" of biofuels. These demarcations are largely artificial and can be refined further, but because they are currently terms-of-art, they will be used in this report.

These terms do not imply that later generations are necessarily superior to earlier generations—just that they use different feedstock and are in different phases of development, and consequently, have different funding needs. There are also general challenges that apply to *all* generations of biofuels.

Part I of this report will identify these obstacles, while Part II presents recommended policy changes and financial tools that can overcome these hurdles, attract more private capital, and scale up investment in biofuels.

[The three] generations [of biofuels] are extremely blurred.... Ten years from now there are going to be plants that are operating profitably in every one of those categories....

Bill Hagy,
Special Assistant for
Renewable Energy Policy,
USDA, Rural Development

The First Generation

Roughly speaking, the first-generation biofuel in the United States is ethanol, which is produced from corn through fermentation, a process that has been employed for thousands of years and understood for centuries. In many ways, this is a mature technology with large-scale industrial production already taking place in the United States and abroad. Extensive infrastructure has been built, beginning with corn crops in the field and ending with the delivery of ethanol- and petroleum-blended fuels. Over the years, greater efficiencies have been achieved in each aspect of the process, from planting to fermenting to distilling. Further refinements continue to be achieved.

These new process efficiencies have changed the energy equation markedly. Whereas only a few years ago, one input of energy into the process yielded only about one output of energy (assuming everything went right), today the situation is improving. One input of energy yields 1.67 outputs of energy when corn is used to produce ethanol.[4] Increased yields from new strains of corn are expected to further increase the efficiency of corn as a feedstock. However, by comparison, in Brazil, where sugarcane is used, one energy input yields 9.3 energy outputs.[5] An oft-mentioned concern regarding first-generation biofuels is their impact on food prices. According to an April 2009 report from the Congressional Budget Office, food prices rose 5.1 percent from April 2007 to 2008. But the CBO estimates that increased corn demand due to ethanol production was responsible for only a 0.5 to 0.8 percent hike, or 10 to 15 percent of the total rise. Increased energy prices drove prices up by 1.1 percent, accounting for more than one-fifth of the increase.[6] Soaring energy prices combined with the huge drop in dollar, not increased ethanol production, were the major contributors to higher food prices in 2008.

In the United States, ethanol is largely sold by refiners to oil companies, which blend it into standard gasoline fuel mixes based upon various federal and state mandates. As a result, while a great deal of ethanol is refined domestically, very little high-ethanol content fuel (such as E85, a blend that is 85 percent ethanol, 15 percent gasoline) is available at service stations. While there are more than 7 million "flex-fuel" vehicles on the road that are designed to use either E85 or gasoline, only around 360,000 vehicles currently run on E85—largely because so few service stations offer the product to consumers.[7] By contrast, Brazil has mandated that all vehicles use at least E25, a blend of 25 percent ethanol and 75 percent gasoline.[8] Although gasoline contains more Btu's per gallon than ethanol, higher-compression internal combustion engines have the potential to increase the mileage delivered by ethanol or ethanol blends,[9] making up for some of differences in energy density between gasoline and ethanol.

The ethanol industry in the United States has seen dramatic ups and downs. With the Energy Policy Act of 2005, interest in producing corn ethanol soared, while rising crude oil, gasoline, and natural gas prices in 2006 drove up ethanol prices.[10] This initial boom did not last, however. Fifty planned ethanol plants were shelved in late 2007 and early 2008,[11] and net returns declined in 2008 due to falling or volatile ethanol prices.[12] This shift in fortunes has been attributed to increased feed costs, structural changes in the market, and the increasingly tight correlation between corn and crude oil prices, given oil's still critical role in the production of corn.[13] Despite the bumpy road already traveled, the industry has managed to survive and today ethanol still accounts for the lion's share of biofuel production.

The Second Generation

Second-generation biofuels are produced from feedstocks that include the cellulose in plants; their production process therefore requires the breakdown of plant cell walls.[14] Feedstocks include biomass waste from corn, wood, wood chips, and nonfood crops such as miscanthus and camelina.

From an industrial point of view, these processes are newer but not as cheap to undertake as the production of ethanol from corn. Different approaches have been taken with regard to cellulosic ethanol production. Some producers have focused on more efficiently using specialized enzymes to break down cellulose, while others have concentrated on producing enzymes more cheaply; still others are attempting to genetically modify the cell walls of plants. In each case, cellulosic ethanol offers the hope of large-scale increases in energy efficiency, in which one input of energy into the process could potentially yield as many as 36 outputs of energy.[15] This is far greater than the 1.67 outputs of energy currently derived from corn ethanol or the 9.3 outputs that can be produced from sugarcane.

Commercial cellulosic ethanol production has taken some notable but small steps forward in recent years, with Iogen Energy Corporation delivering 100,000 liters of cellulosic ethanol to Royal Dutch Shell in 2008,[16] and Verenium Corporation launching construction of its first commercial-scale production plant, capable of producing 36 million gallons per year, in 2009.[17] More recently, POET Ethanol Products secured the final funding to construct its $200 million Project Liberty commercial-scale cellulosic ethanol plant in Iowa, based on its successful pilot plant in South Dakota.[18]

Broadly speaking, however, second-generation investors and the U.S. Department of Energy currently find themselves at odds, despite the fact that the DOE has committed $1.3 billion to biorefineries. Investors, made wary by the recession and tight credit markets, have been reluctant to back specific projects without the assurance of DOE support, while the DOE will not dispense funding until it sees proof of significant private investment. Until this "chicken or the egg" problem is resolved, dozens of plants will continue to be put on hold due to a lack of financing. This delay in construction will make it unlikely that the United States will be able to meet its self-imposed timetable for integrating cellulosic ethanol into the nation's energy portfolio (see figure 1, in the next section of this report).[19]

The Third Generation

Third-generation biofuels have tremendous potential for energy production, efficiency, and minimizing environmental impact, but they are still under development and are furthest from commercialization. Some of these fuels, such as algae-based biodiesel, promise to perform just like petroleum. But their production process has the potential of becoming carbon negative (meaning that the process *removes* CO2 from the atmosphere).[20] Once costs are brought down to a competitive level with other fuel sources, third-generation fuels have huge appeal.

Whereas first-generation biofuels are already commercially viable and the second generation is making strides into commercialization, third-generation biofuels are in the pre-commercialization, venture-funded phase.

Both second- and third-generation biofuels face the important challenges of finding a key nonfood feedstock that can be produced on a large enough scale to compete with corn-based ethanol. The development of such a feedstock would significantly change the landscape of the industry. While still in their infancy,

third-generation biofuels could be game-changers given the lack of controversy surrounding their land use, their low emissions in production and use, and especially their negative carbon footprints. The desired end molecules can be cultivated directly in a feedstock such as algae, eliminating the need for expensive industrial processes.[21]

Research developed in Arizona State University's Algal-Based Biofuels and Biomaterials project has moved from the laboratory to field pilot-scale demonstration and production.

Photo by David Tevis. Courtesy of Arizona State University and Arizona Board of Regents.

One of the most pivotal tasks in building a vibrant biofuels industry will be counteracting the chilling effect on investment that comes from policy uncertainty and the oil market's price volatility.

Part I

Issues & Perspective

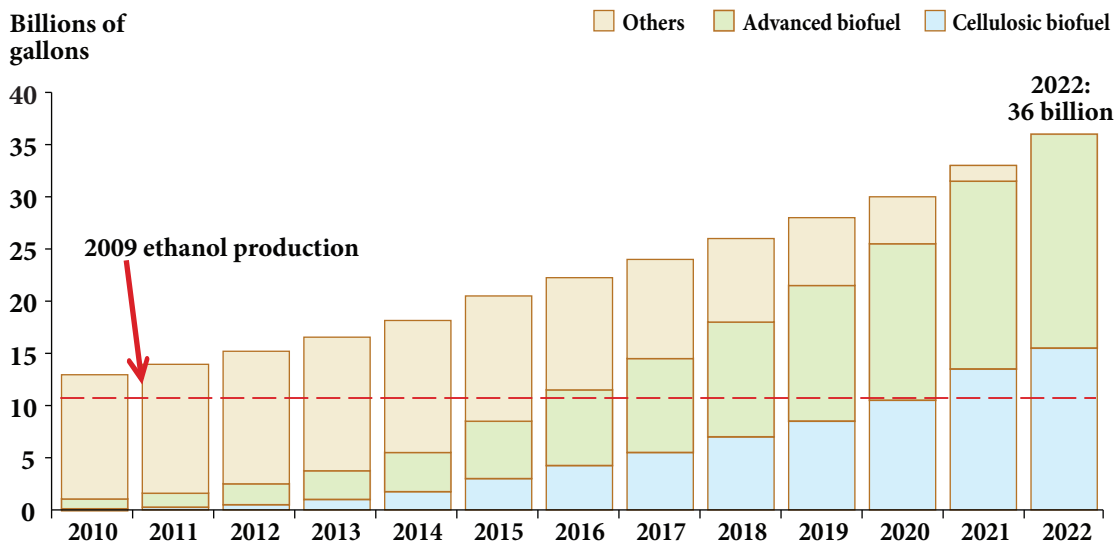
Setting an Ambitious Target

The production of biofuels is expected to increase dramatically in the coming decade. In May 2009, the Environmental Protection Agency (EPA) revised the National Renewable Fuel Standard, raising the volume of biofuels required to be blended into gasoline from 9 billion gallons in 2008 to 36 billion gallons by 2022 (see figure 1). That target figure would represent approximately 11 percent of annual U.S. consumption of gasoline and diesel.[22]

To reach this target, the Obama administration created several new incentives to accelerate progress while augmenting programs already put in place by prior administrations. The USDA's Biorefinery Assistance Program, for example, offers up to $250 million in loan guarantees per project for the development and construction of commercial-scale biorefineries or for retrofitting existing facilities that can develop advanced biofuels.[23] In addition, the U.S. Department of Energy (DOE) is providing loans of $25 million and $50 million to pilot and demonstration plants, respectively. On top of federal programs, a number of states provide grants, revolving credit facilities, subsidies, and tax credits for biofuel producers.

As a result of these and other initiatives, biofuel production is on the rise. Like other forms of energy, biofuels respond to incentives and mandates. By setting a clear target for production, the federal government is assuring producers that it is committed to assisting the industry.

FIGURE 1 *Total Renewable Fuel Standard*



Sources: Energy Independence and Security Act of 2007, Renewable Fuels Association.

Selected Government Commercialization Programs for Biofuel Production as of 2009

A number of incentive programs have been created to promote the research, development, and production of biofuels, including the following:

Environmental Protection Agency:

- Renewable Fuel Standard II mandating that 36 billion gallons of renewable fuel must be blended into the nation's gasoline by 2022

Department of Agriculture:

- Biomass Research and Development Initiative (issued jointly by the USDA and the Department of Energy)
- Renewable energy systems and energy efficiency improvements (grants, loans, and loan guarantees)
- Biorefinery Development Grants
- Biorefinery Assistance Program
- Repowering Assistance
- Bioenergy Program for Advanced Biofuels
- Feedstock Flexibility Program for Producers of Biofuels
- Biomass Crop Assistance Program (BCAP)
- Other supportive and non-exclusive programs
  - Value-Added Producer Grants Program (VAPG)
  - Business and Industry (B&I) Guaranteed Loans ($1 billion annually, to guarantee up to 90 percent of a loan by commercial lender)
  - Rural Business Enterprise Grants (RBEG; focus is on smaller projects)

Department of Energy:

- Biorefinery Project Grants
- Loan guarantees
  - $786.5 million in total as part of a "commercial biorefinery effort"
  - $480 million for integrated pilot and demonstration projects
    - Loans up to $25 million for pilot plants
    - Loans up to $50 million for demonstration plants
- $110 million in research grants in key program areas
- $60 million for ethanol research
- $300 million for the Clean Cities program, a government/industry partnership to put more than 9,000 alternative fuel vehicles on the road and add 542 refueling stations across the nation
- $176.5 million in direct funding for commercial-scale biorefineries

Internal Revenue Service:

- A variety of producer and tax credits targeted toward large and small operations for ethanol, biodiesel, and future renewable fuels. Examples include:
  - Volumetric ethanol excise tax credit of $0.45/gallon
  - Small ethanol producer credit of $0.10/gallon
  - Cellulosic biofuel producer tax credit up to $1.01 per gallon
  - Biodiesel tax credit of $1/gallon (pending congressional approval for extension)
  - Special 50 percent depreciation allowance for cellulosic biofuel plant property

State programs:

- All fifty states and the District of Columbia have standards for the use of alternative fuels.
- Forty-five states have incentive programs in place for alternative fuel use. Most of these incentives take the form of reduced sales taxes, but ten states have production payments for biofuels, and sixteen states have incentives for supporting biofuel infrastructure (primarily fueling stations).

Funding Challenges for the Biofuels Industry

Biofuels are not unique in their reliance on government assistance to spur sales. All energy products have received some form of government support—and some have been doing so for decades. Traditional fossil fuels have historically claimed the lion's share of government support in the aggregate, while ethanol has received the largest recent share when measured on a per-gallon or per-barrel basis.

In addition, several factors need to be taken into account when assessing the economic impacts of government assistance to the biofuels industry. Importing foreign oil is not without costs to the taxpayer, given the resources devoted to protecting shipping lanes and production centers. The nation's continuing dependence on energy imports from unstable regions creates considerable vulnerability. In addition to enhancing U.S. energy security, alternative energy sources such as biofuels present a positive externality to society by reducing—and with some technologies, perhaps even reversing—carbon emissions. These are social returns on the government's investment in the biofuels industry that cannot be fully monetized but must be taken under consideration.

It is estimated that the two major federal incentive programs, the Volumetric Ethanol Excise Tax and the Ethanol Small Producer Credit, cost $8 billion in 2008.[24] Required federal assistance for biofuels will certainly be much higher in order to increase the current 10.75 billion gallon production level to the 36 billion gallon goal set by the EPA for 2022.

The biofuels industry will require initial and perhaps even long-term government programs and mechanisms, but it cannot fully mature without significant investment from the private sector. Private funding will be needed in each segment of the value chain, from research and development through crop and feedstock production and eventually retail distribution and sales. In order to attract sufficient private investment, investors must see this sector as capable of providing acceptable returns.

Can the United States achieve its policy goals regarding the use of biofuels while phasing out government assistance? Policymakers, scientists, and investors are exploring better uses of both public and private funding, and looking at better ways to reduce risks and increase private investment into the sector.

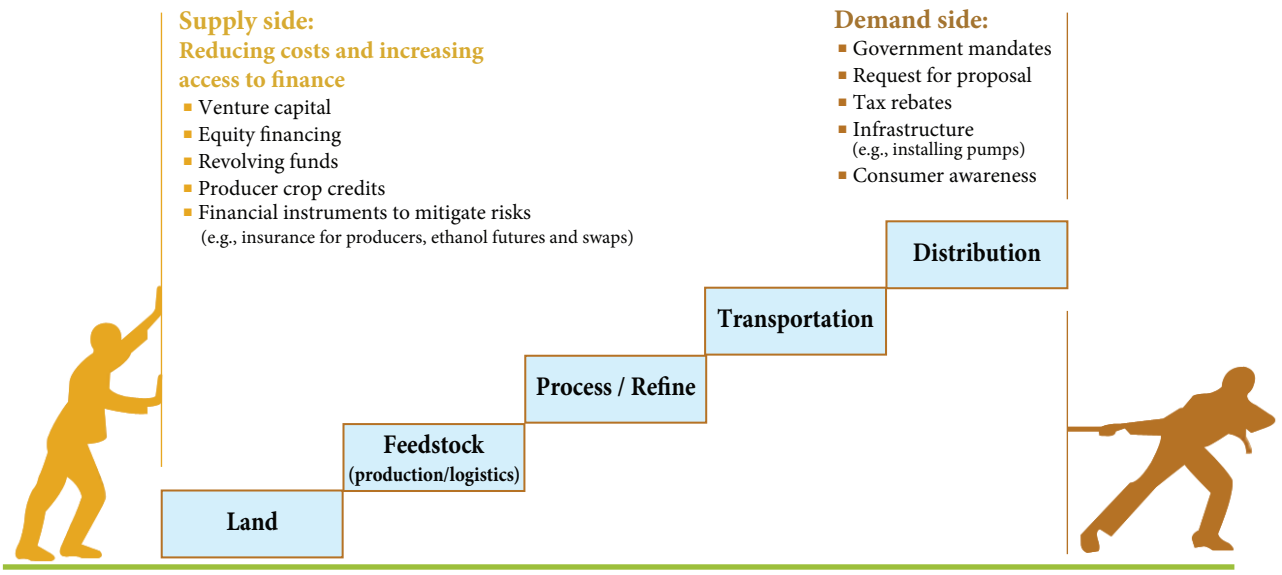
One of the most pivotal components will be counteracting the chilling effect on investment that comes from policy uncertainty and the oil market's price volatility. As recent history shows, when oil prices rise, investment capital often moves into alternative sources of energy. But when oil prices fall, as they do periodically, much of that investment is lost. This cycle, repeated every few years, has discouraged investment commensurate with the enormous size of the market opportunity.

In addition, industry experts are looking at market gaps—areas of inefficiencies in the markets and in the alternative-energy value chain—that need to be addressed for productive investments to yield profitable long-term results.

It is also important to consider what types of defensive measures leading energy producers might take to retain their position in the economy. Faced with a potential loss of market share, oil companies have two general strategies to take: oppose the development of biofuels through negative press, or invest in the sector directly or via joint ventures, as some firms have done.

FIGURE 2

Moving across the biofuels chain



Source: Milken Institute.

Fortunately for the future of biofuels, oil companies are becoming serious investors in this sector. Venture capital has long been a major source of private investment in this sector, and in recent years, oil giants such as Chevron, BP, and Exxon have started venture units and/or partnerships with established venture firms in order to fund biofuels research and production.[25] While the private money currently invested in the biofuels industry is only a small fraction of government spending, it is expected to grow. In 2008, venture capital investment in all alternative fuels—including biofuels—was $639 million,[26] while government assistance for corn ethanol alone in the same year topped $9 billion.[27]

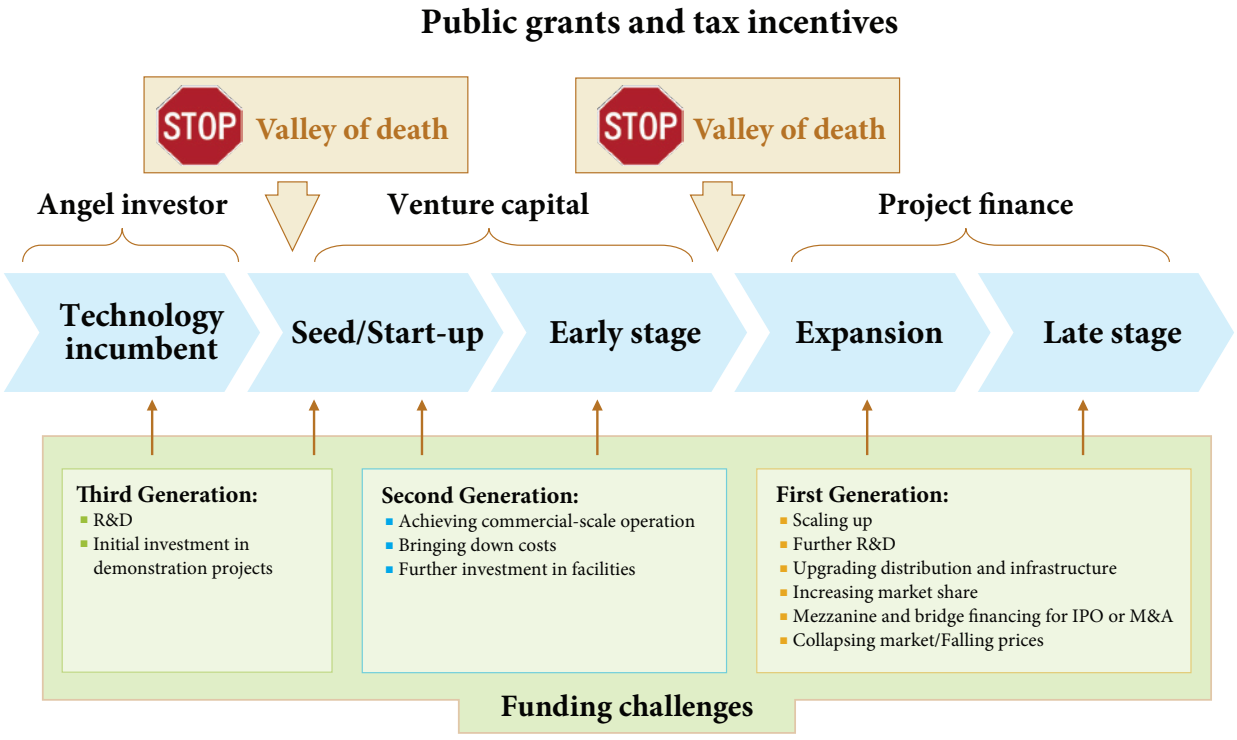
Venture capital is adept at investing in small start-ups, but there is little expertise within the venture community in financing large-scale energy plants, given differences in orders of magnitude and rates of return between venture and project financing. (Venture investment is typically under $10 million, while project financing is typically above $100 million.) This financing gap must be overcome if biofuels are going to progress from the start-up stage to the next level of growth. Many enterprises never find a way to bridge the gap, which is known as the "valley of death." This moniker refers to the fact that small companies often perish at this point for lack of additional investment capital, a shortage that is exacerbated by policy uncertainty and, at the moment, current economic conditions.

There is great urgency to design policies that create incentives for positive outcomes (greater fuel production, more efficient business practices, decreased emissions) and penalties for negative outcomes (sustained reliance on subsidies, deforestation, increased overall carbon emissions) so the industry can grow at a healthy pace and biofuels can assume a larger role in the nation's energy portfolio.

Building a biofuels market with the capacity to supply a significant portion of the United States is a major endeavor. There are different challenges for each generation of biofuels, as they are in different phases of research and production. Ethanol from corn and sugarcane is an established product, but one that requires project financing to reach the scale necessary to service the American transportation sector. Newer technologies, such as cellulosic biofuel derived from waste products (second generation) and biofuels derived from algae (third generation), have considerably farther to travel along the technology stream; they require venture capital to launch demonstration plants before they can reach the next level. There are general challenges that apply to all generations of the biofuels industry, too.

Measures need to be taken to help suppliers cope with uncertainty, as well as to create demand for the end products. A range of potential solutions will be discussed in Part II of this report.

FIGURE 3 *Funding challenges for biofuels*



Source: Milken Institute.

The Financial Innovations Lab

In the Financial Innovations Lab that took place on September 23, 2009, experts from the worlds of finance and economics, science and technology, agriculture and industry, government and academia came together to design models that can leverage public funding with private investment to generate a sustainable market for biofuels.

Defining the Challenge

The Lab began by establishing a framework for understanding the scope of the problem. Joel Kurtzman, Executive Director of the Milken Institute's SAVE initiative, highlighted key issues surrounding the biofuels industry, including the need to mobilize private capital and the opportunities that biofuels present for the environment and investors alike. Misallocated funding, badly designed incentives, and the challenges inherent in scaling up the industry were highlighted as major problems for participants to tackle during the course of the Lab.

Stephen Kaffka of the California Biomass Collaborative focused on how to assess the impact of biofuels from a holistic perspective. Professor Kaffka urged participants to consider biofuels in a larger context that includes the broader economy, the environment, energy security, and sustainability. When it comes to policy remedies, he noted, biofuels must be viewed as a multi-stakeholder undertaking involving many different areas of society.

Kaffka pointed out that biofuels will not be sustainable unless they are produced correctly. The industry must proceed in a way that does not displace food production or lead to deforestation (which actually increases overall carbon emissions). He also pointed out that current policy does not allow for better end results through more diverse practices. New crops could lead to better outcomes, but environmental politics have posed complications (such as restrictions on the planting of energy crops in areas where there is hypersalinity resulting from water policies of the past). Kaffka suggested that because so many policies focus on different aspects of sustainability, the result is a highly complex array of rules with inconsistent incentive structures. This can actually hinder solutions and slow the development and implementation of next-generation technologies that could perform better than current options.

Christopher Groobey, a partner at the law firm of Wilson Sonsoni Goodrich and Rosati, shared observations gleaned from his years of experience in financing the ethanol industry. He pointed out that producers of first-generation biofuels suffered from extreme fluctuations in corn price. Many have already filed for or are now facing bankruptcy; even with the right technology, feedstock, and location, they are still starved by lack of working capital in a bad credit cycle. Investors who came late to the game are more interested in buying old ethanol plants at discounted prices than investing in new technologies and plants. These investors bring little benefit to the truly innovative firms that have been active in R&D over the years.

In the daylong discussions that followed, Lab participants focused on pinpointing the obstacles that currently stand in the way of the full development of the three different generations of biofuels and devising solutions for overcoming them.

The Indirect Land Use Change Issue

Changes in land use as a result of increased demand for biofuel feedstocks (whether corn or biomass) have surfaced as an issue of concern to some interest groups in the debate of food versus fuel. In theory, biofuels production in any country can raise domestic demand for a particular feedstock, tending to push its price higher—and when that same feedstock is traded internationally, the result is upward pressure in other countries, too. Higher prices, and presumably greater profits, will tend to result in increased production of those feedstocks in trading partner countries. For example, higher corn prices in the U.S. could theoretically induce higher corn prices in another country, resulting in shifts of acreage to corn in that country.

That said, there are other drivers of shifts in acreage at play as well. Where reduction of rain forests or grassland is observed, it should be recognized that demand for exotic woods often drives legal and illegal logging. Allocating tracts of land to otherwise landless persons can increase the conversion of forest to agricultural uses. And the increase in demand for cattle grazing can also add to forest clearing pressures. In considering this issue, it is important to recognize the presence of numerous drivers that can result in forest and range land conversion to other uses, many of which have nothing to do with production of biofuel feedstocks. Admittedly, increased demand for corn in the U.S could raise corn prices and that effect could induce price increases elsewhere around the world. But in fact, the U.S. has continued to produce enough corn to meet all its export demand and has increased its own corn acreage to meet increased demand for biofuel feedstocks. In the U.S., as biofuel production has grown, corn carryover stocks have also increased.

Finally, the issue of indirect land use change drivers is made even murkier by the lack of reliable data on the actual land use changes that are occurring around the world, especially in countries with rain forests, and the lack of metrics explaining cause and effect relationships. While the issue is one of legitimate policy interest, much more research is necessary before any definitive judgments can be made as to the actual effect of higher biofuel feedstock prices on land use change pressures worldwide.


Long-term forward contracts, a well-developed and widely used financial instrument, can be used by both producers and potential investors to achieve more sophisticated risk management.

Part II

Financial Innovations for Biofuels Development

Identifying the Barriers

The major barriers to funding and growth in the biofuels industry are outlined below:

Barrier 1: Regulatory uncertainty

Regulatory uncertainty was identified by Lab participants as a "principal chilling factor" that discourages private investment. Although government policies in the past decade have largely favored the biofuels industry, uncertainties remain a key concern of current and potential investors. Negative policy shocks have occurred in the past: The California Low-Carbon Fuel Standard approved by California Air Resources Board in April 2009, for example, was criticized by many as posing an unfair penalty to corn-based ethanol.

Also, most current government incentives for the biofuels industry are provided in the form of subsidies or tax credits. Investment decisions were made based on these incentives. When too many programs are enacted at the same time, however, excessive capital can cause the industry to overbuild. Incentives initially created a land-rush that brought money into the corn-derived ethanol industry at inflated valuations. The result was a boom-to-bust roller-coaster ride.

In addition, short-term incentives can change significantly because of political pressure or budgetary constraints. For biofuel firms that rely heavily on debt financing, the changing policy dynamic can influence cash flows, making it even harder to survive the valley of death.

Lab participants suggested that regulators should establish *consistent, long-term policies* for developing the biofuels industry, thus sending coherent signals to investors and building a stable regulatory platform that can outlast changes in administration or shifts in the political and budgetary winds.[28]

Barrier 2: Uncertainty in supply and feedstock prices

The sharp increase in corn prices witnessed in 2007 and 2008 was a major factor behind the bankruptcy of many ethanol producers, whose businesses were not yet robust enough to survive large fluctuations in feedstock prices.[29] Ethanol firms that relied heavily on debt financing could not keep a positive cash flow when the cost of production squeezed their already-thin profit margins. Second- and third-generation biofuels will eventually face the same challenge as demand rises for the feedstock they use. Lab participants believe that financial instruments could be designed to hedge such risks.

Weather risk is another reason for fluctuations in prices. Biofuels (with the possible exception of some types of experimental algae production) rely on outdoor farming, and it is not possible to precisely control the output of feedstock whenever weather is involved. Extreme weather conditions can cause sharp decreases in supply, and hence spikes in price—but this particular kind of price volatility cannot be traded away unless the feedstock supply is diversified by trading with other countries.

In addition, shifts in demand can cause unexpected increases in feedstock prices. Biofuel producers need tools to hedge against negative shocks from both the supply side and the demand side.

Barrier 3: The Valley of Death for Next-Generation Biofuels

First-generation biofuels managed to make it through the valley of death. However, this outcome was described by one participant as "a combination of luck and policy," which cannot be fully replicated by the second and third generations.

Several second-generation pilot plants are currently under construction, but not many are in operation. In this environment, potential investors would rather wait and see the outcome of current projects before proceeding ahead with their own—and this reluctance has slowed the industry's overall development. Many Lab participants stressed the urgency of helping demonstration plants move forward and encouraging private capital to provide funding so that the second and third generations can mature and grow to scale.

Barrier 4: Market Failures and Dysfunctional Capital Markets

Many investors in first-generation biofuels were burned badly in 2006 and 2007, as spiking corn prices, overbuilding, and regulatory uncertainties bankrupted many firms. Without essential changes in the industry and new tools to insulate investors from the various risks that became apparent in the first-generation experience, private investors are reluctant to provide funding again, especially for new technologies. Instead, some are opting to buy old-technology ethanol firms at deeply discounted prices. While consolidation within an industry is usually healthy and can lead to better use of capacity, in this sector, a market failure results when new, more efficient, and perhaps more environmentally friendly technologies are developed by biofuels firms but not rewarded by investors.

The situation has been further exacerbated by the financial crisis and the ensuing recession. With credit markets essentially frozen from 2008 into 2010, it has been extremely difficult for biofuel producers to use term funding to pull themselves through the start-up phase.

Loan guarantees are best used for helping bridge the value of debt as far as moving technology forward. But it's not going to help the fundamental risk of the industry as far as commodity price risk and the lack of a long-term forward market.

Paul Ho,
Hudson Clean Energy Partners

The Financial Innovations Lab brought together a number of industry experts, including Corinne Young, Director of Government Affairs for Myriant Technologies LLC, which develops second-generation biofuels.

Barrier 5: Lack of debt financing

Small businesses rely on both equity financing and debt financing. Debt financing allows firms to use appropriate leverage and is usually available on more flexible terms. However, biofuel firms find it difficult to obtain bank loans, largely because of the long-term nature of the investment that is needed. Biorefineries, for example, need to be funded via ten- to thirty-year loans. These enterprises have relatively thin profit margins, and are faced with enormous uncertainties from both regulations and the marketplace.

Without a mechanism for securitization, banks must keep these long-term assets on their balance sheets; they are forced to account for the interest-rate risk and the risk of not being able to roll over short-term credits during a downturn. This combination of factors has left banks reluctant to lend to biofuel firms. No strategy has yet been implemented for effectively mobilizing other private capital to provide loans while receiving a reasonable rate of return. Lab participants outlined ideas for new models that can fill this gap; these are detailed in Solution 5 of this report.

Barrier 6: Little availability to consumers

At present, ethanol is used primarily as an additive in gasoline. While there are now large numbers of vehicles capable of using E85 (a mixture of 85 percent ethanol, 15 percent gasoline) and cheap conversion kits are available for cars, very few retailers sell this type of fuel. The lack of retail outlets has hampered demand for first-generation biofuels.

In addition, Lab participants pointed out that currently there is an absence of consistency for biofuels. This hinders broad acceptance, as consumers want clear product information and reliable sources of supply. The federal government could and should do more to provide authoritative facts and establish industry standards.

Crafting Solutions: Financial and Policy Innovations

Solution 1	*Expand the Biofuels Interagency Working Group and create more effective coordination and communication*

Today multiple federal agencies have their own biofuel programs in place. Lab participants observed that some momentum is lost when biofuel producers compare the different programs available and try to figure out which deal is the best. Close examinations of core agency expertise and capabilities, as well as a greater degree of coordination among agencies, are needed to improve efficiency.

In May 2009, President Obama announced the establishment of the Biofuels Interagency Working Group, co-chaired by the secretaries of Agriculture and Energy and by the administrator of the EPA. The formation of such a working group is a positive step toward better coordination among federal agencies.

Lab participants applauded this move, but suggested further strategies to improve the effectiveness of the collaboration. They recommended bringing the Treasury Department into the working group, since it is implicitly involved in the renewable energy sector through tax credits and grants. The presence of Treasury would not only give the group additional credibility for investors, but would also bring important perspective to discussions about funding.

Additionally, Lab participants stated that the key to the working group's success would be its ability to coordinate the senior leadership of different agencies. Regular face-to-face meetings would encourage meaningful communication and lead to an expedited decision-making process. Efficient access to budget data, departmental expertise, and resources will help agencies share information quickly and make policy decisions with a greater depth of understanding than would be possible if they acted individually.

Participants felt that each of the participating agencies should allocate dedicated budgets for biofuel programs, but consider joint reviews of solicitations for grants. Currently the Biomass R&D Technical Advisory Committee advises the DOE and USDA on technical evaluation of proposals. It was suggested that while government agencies can rely on scientists to address technical concerns, more experienced investors and banks should also have a larger presence in such a committee for a thorough review of the commercial feasibility of potential projects. The most promising projects could then receive expedited grants and guarantees, thus moving more quickly from pilot and demonstration programs to commercialization.

A follow-up note: In February 2010, the White House's Biofuels Interagency Working Group released the report *Growing America's Fuel*, in which several recommendations were made that align with those suggested at the Lab.

> *[N]ow there is a solid mix of programs that address everything from feedstock all the way through market … but [there is a need to] integrate and coordinate the application of these policies and then to work more with industry and financial interests to fine-tune them, make them more user friendly, and fund them expeditiously.*
>
> *Corrine Young, Myriant Technologies*

SOLUTION 2

Establish tolling arrangements for pilot plants

Two approaches were suggested by Lab participants to help pilot plants survive the valley of death. One is for the government to play a key role in the process by creating a feedback profit incentive chain. Through this kind of arrangement, the biofuel producer receives public funding while contractually agreeing to funnel a portion of profits back into the plant, ensuring that the producer maintains continued interest in the improvement of the plant rather than in extracting profits.

Tolling arrangements offer another approach that would guarantee profit for demonstration plants for a period of time. These mechanisms have proven to be an effective model for the power industry, and are now being adopted by other alternative energy industries. When signing a tolling arrangement contract, biofuel producers receive feedstocks from the counterparty and promise to produce and deliver biofuels under a cost-plus agreement, in which the price for the end product is set at a level that is determined by all input prices. This kind of arrangement effectively locks in a certain profit margin for biofuel producers.

These arrangements are needed since investors are reluctant to take a chance on building the "first" successful next-generation biofuel plant because of the huge uncertainties involved in investing in a new technology. The first successful plant will sink a large chunk of capital into R&D investment. But once it is operational and proven successful, a host of competitors will pursue the same technology, potentially eliminating the gains of the first producer (and in fact penalizing that company for expending so much in R&D). As private investors do not wish to jump into such a market, government should play an active role in encouraging the development of demonstration plants.

SOLUTION 3

Employ crop insurance

The biofuels industry faces a combination of seasonal, crop, and weather risks that are not present with other fuel industries. The natural gas and oil markets have their own unique set of risks that are addressed in the aggregate by using tools such as long-term storage facilities and management of reserves. But feedstock growers are subject to a greater frequency of risk, and these issues pose a much larger problem for this relatively young industry.

Unchecked volatility in supply will have a greater impact on the smaller biofuels market than it does on the more mature gasoline market. If a few plants are unable to operate due to the lack of feedstock (or any other reason), it ripples through a more significant proportion of the market (by contrast, the effects on the oil market are relatively contained if a few refineries shut down). The lack of backup supply would shake confidence in the overall biofuels market. This discrediting would lead to a chain reaction in which creditors lose the confidence to continue funding biofuels. One bad year in the early years of a biofuel plant's life can have an outsized effect on the market as a whole and create a major issue for feedstock growers in the United States.

Another problem faced by feedstock producers is price instability. Their faith in biofuel feedstock profits could be shaken by a temporary but sharp price decline. If they opted out and switched to more traditional crops, it would have a large impact on biofuel supplies.

Marv Duncan, Senior Agricultural Economist at the USDA's Office of Energy Policy and New Uses, summed up the problem of feedstock dependency and the need for crop insurance to mitigate the issue:

We also are dealing with feedstocks that do not have a ready market, apart from the market to a particular processing plant. In the case of cellulosic biomass, we're probably looking at a 50-mile radius around the plant as the catchment basin for the feedstock. If the plant goes out of business, or otherwise reneges on a purchase contract, the farmers who have committed to producing the feedstock will be left high and dry. Consequently, we believe some type of insurance mechanism will be needed to assure payment for the biomass contracted to the biofuel plant. Establishing such a specialized insurance program may require the joint efforts of both the private sector and the federal government.

Crop insurance can effectively help mitigate such risks. The modern federal crop insurance program, provided by the USDA, has been proven extremely successful in helping farmers reduce risks like the ones mentioned above. The program is essentially a public-private partnership: The federal government provides subsidies and reinsurance, while private insurers deliver coverage.

Some of the policies currently offered by the USDA's Risk Management Agency are for food crops, but could be applied to the feedstock market:

- **Crop revenue coverage (CRC):** Provides revenue protection based on price and yield expectations by paying for losses below the guarantee at the higher of an early-season price or the harvest price.
- **Group risk income protection (GRIP):** Makes indemnity payments only when the average county revenue for the insured crop falls below the revenue chosen by the farmer.
- **Income protection (IP):** Protects producers against reductions in gross income when either a crop's price or yield declines from early-season expectations.
- **Revenue assurance (RA):** The producer chooses the level of coverage by selecting a dollar amount from a range defined as 65 to 75 percent of expected revenue.
- **Catastrophic coverage (CAT):** Pays 55 percent of the established price of the commodity on crop losses in excess of 50 percent. The premium on CAT coverage is paid by the federal government; however, producers must pay a $300 administrative fee (as of the 2008 farm bill) for each crop insured in each county. Limited-resource farmers may have this fee waived. CAT coverage is not available on all types of policies.

To improve on the current crop insurance program, Lab participants suggested that private insurers should be allowed and encouraged to provide additional assistance that goes beyond the scope of USDA insurance programs. A vibrant insurance market could underwrite a crucial portion of the risk sustained by producers and encourage more funding of these plants. Participants also agreed that the government should not set a cap on feedstock prices.

Having both public and private policies for feedstock producers is a ground-up measure that not only benefits the farmer, but also assures biofuel refiners that their feedstock supply is protected. By providing an insurance mechanism to protect farmers from both financial and natural risks, government and private agencies could provide greater stability to the feedstock market.

SOLUTION 4

Long-term forward markets

More can be done to mitigate the risks posed by fluctuations in crop and output prices. Lab participants suggest that the government should take the initiative to establish long-term forward markets so that feedstock growers, biofuel producers, and investors can reduce price risks.

A futures market already exists for corn. By trading standardized contracts, producers and suppliers can hedge against price fluctuations and make plans for long-term production. Non-standardized forward contracts can also be used for the same purpose. Forward markets for feedstocks other than corn, however, still need to be developed. The ability of these markets to work effectively will have important implications for the risk-management practices available to second- and third-generation biofuel firms.

Perhaps equally important, a long-term forward market should be established for end products. With future demand and profit margins locked in, biofuel producers could plan future production without having to deal with excessive uncertainties in demand. Meanwhile, investors could enjoy greater confidence that would encourage them to make significant long-term investments.

Lab participants stressed the importance of biofuel firms making risk management a top priority. A well-designed and -executed risk-management strategy would involve hedging with respect to input costs and product prices. Such a strategy should be tailored to allow the company to manage through bad cycles and maintain a positive margin. Long-term forward contracts, a well-developed and widely used financial instrument, can be used by both producers and potential investors to achieve more sophisticated risk management.

Alan Boyce, President and CEO of Adecoagro, leads a discussion about overcoming the obstacles to financing second-generation biofuel production.

Solution 5 — *Create a "Greenie Mae" for securitization*

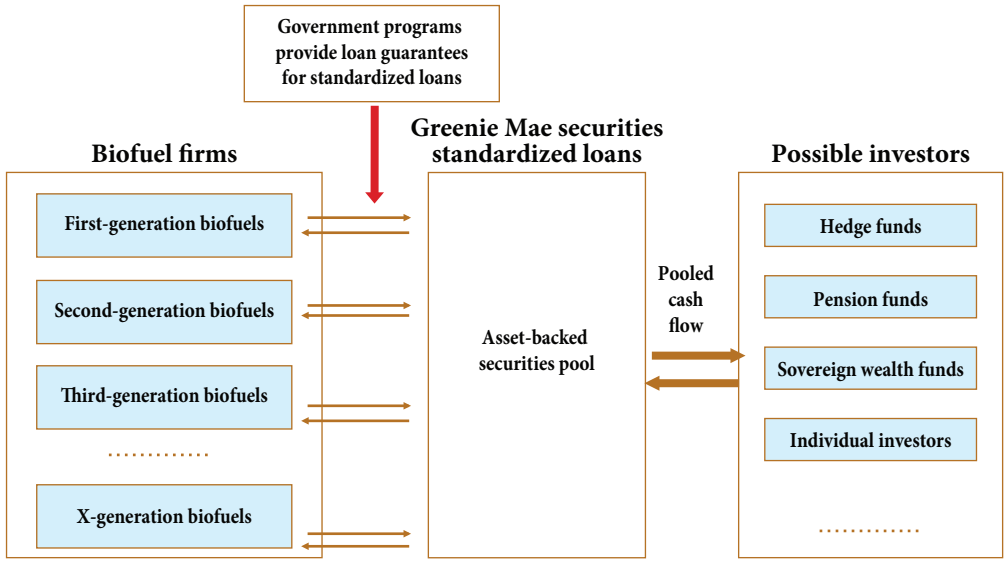
The biofuels industry needs a great deal of capital in order to get its products to consumers. From soil to the pump, biofuels production involves major fixed and variable costs, from the fertilizer necessary at the feedstock level to the steel and concrete necessary to build the plants.

Currently, the USDA and DOE both offer loan guarantees and grants to support biofuel plant construction in the United States. These incentives are not insignificant. For example, as previously mentioned, the USDA's Biorefinery Assistance program offers a maximum $250 million loan guarantee per project. This is aimed at the more established biofuel producers with clear potential to scale to commercial levels.

It is important to realize, however, these programs alone do not provide sufficient capital to expand biofuel projects to the scale that is necessary to make a significant dent in the nation's need for transportation fuel.

Loan guarantees can't work without loans. The goal of handing out loan guarantees should be to encourage private capital to lend to biofuel plants. An efficient and extensive model for a government loan guarantee program already exists in the residential housing sector. Despite the problems that have surfaced since 2007 in mortgage-backed securities, it is worth remembering that securitization functioned smoothly for decades and successfully expanded the housing market for millions of families who have not experienced any problems. It is possible to draw on the examples of Ginnie Mae, the FHA, and the VA while putting measures into place that will avoid the problems that became apparent during the meltdown.

Figure 4 — *A possible model for securitization*



Source: Milken Institute.

Lab participants suggested that government loan guarantee programs within the USDA and DOE could be used to tailor and standardize loans, which then could easily be securitized by a proposed "Greenie Mae." This would eventually create a liquid asset–backed securities market in which guaranteed securities can trade on an option-adjusted spread of LIBOR without any other government assistance. Standardized and transparent, such a market could provide financing at terms that are hundreds of basis points lower in yield than any government loan guarantee program, thus significantly lowering financing costs for developers.

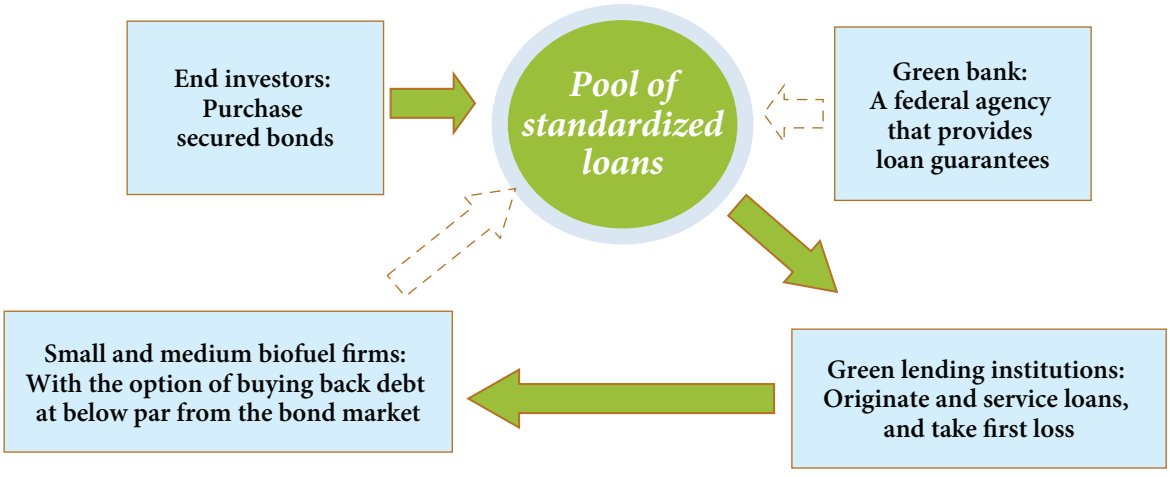
Attendees also floated an alternative idea to "Greenie Mae" involving a covered bond model. This model involves servicing secured debt in the form of standardized bonds to finance small and medium-sized projects. A federal agency, or "green bank," can be established to be an insurer for the bond market.

There are five primary proposed steps involved in setting up a green bank:

- Establish the federal guarantor as an independent agency
- Create standardized debt terms
- Define credit structures
- Create funding mechanisms
- Establish a forward market for biofuel bonds

Credit structure is a key component of this model. It should be designed so that loan originators (green lending institutions) must reserve capital against a 5 to 20 percent first loss guarantee. Consequently, loan originators would retain some "skin in the game" and incentives would be correctly aligned. To be able to do so, they need to satisfy certain capital requirements.

FIGURE 5 *A green bank*



Source: Milken Institute.

When bonds are traded at a loss, bond issuers have the option to retire debt by purchasing bonds back from the market at the market price. They can then choose to refinance at a lower interest rate, hence reducing the interest risks for borrowers. The counter-cyclical properties of the green bank provide protection for developers, lenders, and guarantors. Capital flow generated from this model would be able to cover larger projects for a longer time period. No extra burden would be imposed on taxpayers if the model is properly implemented and leveraged.

Another idea presented as an alternative to loan guarantees was for the government to pursue equity matching. In this model, the risks taken by businesses are matched by equivalent risk taken by the government. This approach not only allows the federal government to lessen the risks assumed by businesses by taking an equivalent share of the investment, but also provides the government with upside investment potential, thereby creating an opportunity for taxpayers to enjoy returns.

Solution 6

Upgrade infrastructure and add retail outlets

A prosperous biofuels industry hinges on building greater demand from end-users. Consumer behavior will ultimately determine the success or failure of this effort. Several measures can be taken to increase consumer acceptance of biofuels, thus raising demand:

- Upgrade the current fuels infrastructure to accommodate ethanol.
- Expand retail outlets. Most filling stations do not have ethanol pumps; installing them can increase consumer awareness and stimulate demand. Increasing visibility and availability while encouraging the development of biofuel-friendly cars will make the industry more sustainable.
- Increase consumer awareness by promoting industry standards, educating the public, and ensuring reliable and widely available sources of supply.
- Introduce legislation to increase the production of flex-fuel vehicles.

These measures would lead to a greater degree of transparency and sustainability in the biofuels industry. Although they are not strictly "financial innovations," they are solutions that can substantially accelerate the development of the biofuels supply chain.

Challenges for the Future

- What can be done to ensure that corn ethanol is on track to become environmentally friendly when measured on a life-cycle assesment?
- What needs to be done to increase the energy output-to-input ratio for corn ethanol?
- How can policymakers reach an accord with environmentalists on land-use issues?
- Given the boom-and-bust story of the early ethanol plants, investors remain skittish. As a result, they now want to be the second to invest in order to better understand the real economics of biorefineries and the ultimate market price of biofuels. What can be done to persuade investors to put more of their capital at risk?
- Are there better end molecules than ethanol? If so, how can they be exploited and commercialized?
- In some cases, it has proved difficult for investors to gain access to government funds allocated to alternative energy and biofuels. What needs to be done to make government agencies more responsive?


Policy solutions need to be long-term in nature, and designed to eventually help this market function on its own without such extensive government support.

Conclusion

Biofuels hold great promise for addressing the economic, environmental, and security issues inherent in U.S. dependence on imported oil.

Ethanol derived from corn is already economically viable, and is becoming more so over time. This sector of the biofuels industry now accounts for 6 percent of U.S. transportation fuel. New methods for developing, planting, and raising crops and refining corn products into ethanol have increased energy yields significantly. There is no reason to believe that these increases in efficiency will not continue, especially if the market and investment problems mentioned in this report are addressed.

But second- and third-generation products still need more investment in research and development before they can be commercially viable or competitive with corn-derived ethanol. Even so, there is little doubt that new technologies and processes will be able to convert cellulosic feedstocks, municipal and other waste products, and algae and other biological forms into useful molecules—and eventually do so economically.

These fuels provide many of the most desirable attributes of petroleum-based fuels, including:

- **Energy density:** The fuel output must be sufficiently dense and cost-effective to power vehicles.
- **Transportability:** We have to be able to safely transport these fuels in order to be competitive.
- **Use of existing infrastructure:** The United States has a vast and established network of gas stations. Biofuel needs to be supplied at these locations or others, without prohibitive switching costs for providers and consumers.

The correct end molecule will be able to address all of these issues.

Together, the three generations of biofuels have the potential to offset a large share of petroleum-based fuels. The United States can create a domestic industry and generate new jobs, and do so in a way that is environmentally sustainable. Over the long term, the nation can leverage its tremendous agricultural productivity and its bioscience leadership into an export industry for these fuels.

As exciting as this prospect might sound, there are major obstacles to overcome:

- The public knows too little about biofuels and their promise. As a result, there are many erroneous assumptions, especially about corn-derived ethanol. In addition, some environmentalists have criticized biofuels because they are good but not perfect. *This is an education problem*.
- The United States needs a streamlined, holistic policy approach that includes all relevant federal bodies and links to state groups as well. At present, the policy framework is a patchwork of incentives, assistance, and penalties that are difficult to navigate and sometimes contradictory. *Overcoming this requires government coordination at the right levels*.
- Much of the emphasis to date has been placed on jumpstarting production, but distribution problems have never been adequately addressed. *More needs to be done to expand the availability of ethanol at service stations, creating a nationwide network of retail outlets.*
- Biofuels are an agricultural product. For grass-based feedstock, seasonal and weather risks need to be managed. Other risks, such as the cost of inputs and unstable market prices, need to be addressed as well. *Crop insurance and other risk-management programs should be open to this sector.*
- There are insufficient financial mechanisms at present to create a truly robust industry. *There is a need for green banks, loan guarantee programs, and expanded credit facilities*.

The solutions identified by Lab participants and detailed in this report would not only stimulate supply, but would create demand and facilitate financial intermediation.

At the end of the day, it seems that the government is expected to shoulder much of the responsibility. It is true that the government is the most logical entity that can take the lead in setting up the loan guarantee market, the insurance market, and the forward market—but those steps must be taken if we are to achieve the ultimate goal of attracting a vast wave of private capital.

Indeed, many Lab participants agreed that the federal government should serve as a "safe harbor" to instill confidence in private investors. It is important that policymakers bear in mind that short-term subsidies and tax credits, generous though they may be, are not the answers that will empower biofuel producers and investors. Policy solutions need to be long-term in nature, and designed to eventually help this market function on its own without such extensive government support. This is the only sensible strategy for leveraging private capital in the biofuels industry without adding an extra burden to taxpayers.

Policymakers must understand that if biofuels are to become a major source of fuel in the United States, their scale could dwarf most other areas of the agriculture sector. Supplying energy for the nation's transportation needs is a $2 trillion-plus industry. The biggest service that policymakers can perform is to remove the roadblocks that have so far prevented this enormous new sector from getting off the ground. The framework they put in place must be robust enough to form an infrastructure that is equal to the task.

If policymakers get this right, the benefit to the United States will be enormous. In addition to addressing climate change, enhancing national security, and reducing the trade deficit, the increased adoption of biofuels can benefit agricultural producers in rural America. Successfully building a vibrant, mature biofuels industry could have a transformative effect on the U.S. economy.

Appendix

*Financial Innovations Lab Participants**

**Affiliations at time of the Lab*

G. Chris Andersen
Founding Partner
G.C. Andersen Partners LLC

James Anderson
Director, NY Branch
WestLB

James R. Barth
Senior Finance Fellow
Milken Institute

Harry Baumes
Associate Director,
Energy Policy and New Uses
U.S. Department of Agriculture

Alan Boyce
President and CEO
Adecoagro

Matt Caswell
Regulatory Affairs Director,
Biofuels
BP

John Conrad
President
John W. Conrad III & Company

Roger Conway
Director
U.S. Department of Agriculture

Marvin Duncan
Senior Agricultural Economist
U.S. Department of Agriculture

Craig Evans
Director of Government Affairs
New Planet Energy

Douglas Faulkner
President
Chrysalis Energy Partners

Chris Groobey
Partner
Wilson Sonsini Goodrich & Rosati

Lewis Hagedorn
Commodity Analyst
JPMorgan

William Hagy
Special Assistant for
Renewable Energy Policy
U.S. Department of Agriculture

Paul Ho
Managing Director
Hudson Clean Energy Partners

Nathalie Hoffman
CEO and Managing Member
California Renewable Energies LLC

Elizabeth Jones
Director, Congressional Relations
American Farm Bureau Federation

Stephen Kaffka
Director
California Biomass Collaborative

Joel Kurtzman
Senior Fellow
Milken Institute

Tong Li
Research Economist
Milken Institute

Caitlin MacLean
Manager of Financial
Innovations Labs
Milken Institute

Michael Manella
Scientist II
Archer Daniels Midland Company

Rafi Musher
CEO
Stax Inc.

Candace Roper
Senior Vice President and Division
Manager
CoBank Knowledge Exchange

Lawrence Russo
Technology Manager
U.S. Department of Energy

Mark Scanlan
VP, Agriculture and Rural Policy
Independent Community
Bankers of America

Jef Sharp
Executive Vice President
Qteros

Kay Siegel
Director
H2SAFE LLC

Mindy Silverstein
Director, Strategic Partnerships
Milken Institute

Samantha Slater
Vice President, Government Affairs
Renewable Fuels Association

Gregory Tassey
Senior Economist
National Institute of Standards
and Technology

Brian Vo
Research Consultant
Milken Institute

Michael Weinstein
Chief Financial Officer
Ix Energy

Irene Xiarchos
Natural Resource Economist
U.S. Department of Agriculture

Corinne Young
Director of Government Affairs
Myriant Technologies LLC

Endnotes

1. Katie Howell, "KLM Carries Passengers in Biofuel Test Flight," *New York Times*, November 23, 2009, http://www.nytimes.com/gwire/2009/11/23/23greenwire-klm-carries-passengers-in-biofuel-test-flight-92575.html (accessed December 16, 2009).

2. John Makower, "Clean Energy Trends 2009," Clean Edge, March 2009.

3. U.S. Department of Energy, press release, "Secretaries Chu and Vilsack Announce More Than $600 Million Investment in Advanced Biorefinery Projects," http://www.energy.gov/news2009/8352.htm (accessed December 29, 2009).

4. Hosein Shapouri, James Duffield, and Michael Wang, "The 2001 Net Energy Balance of Corn-Ethanol," USDA, 2004, http://www.usda.gov/oce/reports/energy/net_energy_balance.pdf (accessed December 29, 2009).

5. Isaias C. Macedo and Joaquim E.A. Seabra, "Mitigation of GHG Emissions Using Sugarcane Bioethanol," in *Sugarcane Ethanol: Contributions to Climate Change Mitigation and the Environment*, Peter Zuurbier and Jos van de Vooren, eds. (Wageningen Academic Publishers, 2008).

6. Congressional Budget Office, "The Impact of Ethanol Use on Food Prices and Greenhouse-Gas Emissions," April 2009, available for download at http://www.cbo.gov/ftpdocs/100xx/doc10057/04-08-Ethanol.pdf (accessed January 26, 2010).

7. U.S. Department of Energy, Alternative Fuels and Advanced Vehicles Data Center: Vehicles, http://www.afdc.energy.gov/afdc/data/vehicles.html (accessed December 16, 2009).

8. Makower.

9. http://web.mit.edu/newsoffice/2006/engine.html

10. Jason Henderson, "The Impact of the Ethanol Boom on Rural America," Federal Reserve Bank of St. Louis, *Regional Economic Development* 5, no. 1 (2009): 65-73, http://research.stlouisfed.org/publications/red/2009/01/Henderson.pdf (accessed December 23, 2009).

11. Jon Birger, "The Ethanol Bust," *Fortune*, February 28, 2008.

12. Henderson.

13. Ibid.

14. Climate Techbook, "Cellulosic Ethanol," The Pew Center on Global Climate Change, http://www.pewclimate.org/docUploads/Cellulosic-ethanol-11-09.pdf (accessed December 23, 2009).

15. Rob Covey, "Biofuels Compared," *National Geographic*, October 2007, http://ngm.nationalgeographic.com/2007/10/biofuels/biofuels-interactive

16. "Shell Receives Cellulosic Ethanol from Iogen," *Ethanol Producer Magazine*, http://ethanolproducer.com/article-print.jsp?article_id=4991 (accessed December 29, 2009).

17. Verenium Corporation press release, "Verenium Announces First Commercial Cellulosic Ethanol Project," January 15, 2009, available for download at http://ir.verenium.com/releases.cfm (accessed January 26, 2010).

18. Daniel McCoy, "POET Gets $5.25 Million for Iowa Ethanol Plant," *Wichita Business Journal*, January 26, 2010, http://www.bizjournals.com/wichita stories/2010/01/25/daily12.html (accessed January 26, 2010).

19. Naureen S. Malik, "Cellulosic Ethanol-Mandate Faces Snags," *Wall Street Journal*, December 28, 2009.

20. A.B.M. Sharif Hossain, "Biodiesel Fuel Production from Algae as Renewable Energy," *American Journal of Biochemistry and Biotechnology* 4, no. 3 (2008): 250–254.

21. Ibid.

22. "EPA Proposes New Regulations for the National Renewable Fuel Standard Program for 2010 and Beyond," http://www.epa.gov/OMS/renewablefuels/420f09023.htm

23. USDA, Biorefinery Assistance Program Fact Sheet, federal catalog number 10.865, http://www.rurdev.usda.gov/ia/rbcs_9003_Fact_Sheet.pdf.

24. John M. Urbanchuk, "Contribution of the Ethanol Industry to the Economy of the United States," February 22, 2010, http://www.ethanol.org/pdf/contentmgmt/2009_ethanol_economic_contribution.pdf.

25. Matthew Campbell and Eduard Gismatullin, "Exxon to Invest $600 Million in Biofuels Development," Bloomberg, July 14, 2009.

26. "Cleantech Drives Through Stormy 2008," PricewaterhouseCoopers, February 2009, http://www.pwc.com/en_US/us/point-of-view/assets/pwc_pointofview_cleantech_insert.pdf

27. "EPA Proposes New Regulations for the National Renewable Fuel Standard Program for 2010 and Beyond," EPA-420-F-09-023, May 2009, http://www.epa.gov/OMS/renewablefuels/420f09023.htm

28. On February 3, 2010, President Obama and Secretary of Agriculture Tom Vilsack, along with other cabinet members, announced several initiatives including publication of the final rule on the RFS2, a proposed rule on the Biomass Crop Assistance program, and publication of the "Growing America's Fuel" report (http://www.whitehouse.gov/sites/default/files/rss_viewer/growing_americas_fuels.PDF). The report provides a highly focused supply chain approach to be used to support the RFS2 and the President's Biofuel Directive issued on May 5, 2009. This report addresses some barriers that were laid out at the Lab session.

29. Robert Bryce, "Ethanol Bankruptcies Continue, 14 Studies Have Exposed the High Costs of Ethanol and Biofuels," *Energy Tribune*, February 4, 2009.

SCALING ENTERPRISE FINANCE

The Future of Biofuels

1250 Fourth Street
Santa Monica, California 90401
Phone: (310) 570-4600 Fax: (310) 570-4601
E-mail: info@milkeninstitute.org
www.milkeninstitute.org

MILKEN INSTITUTE