

UNLEASHING THE POWER OF THE BIO-ECONOMY

FINANCIAL INNOVATIONS LAB® REPORT



MILKEN INSTITUTE

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Financial Innovations Labs[®] bring together researchers, policymakers, and business, financial, and professional practitioners 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.

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TABLE OF CONTENTS

INTRODUCTION.....	1
ISSUES AND PERSPECTIVES	5
INDUSTRY OVERVIEW	5
INDUSTRY BARRIERS	7
BARRIER 1: BRIDGING THE READINESS GAP.....	7
BARRIER 2: PERCEIVED MARKET UNCERTAINTIES.....	9
BARRIER 3: POLICY UNCERTAINTY AND COMPLEXITY	10
FINANCIAL AND POLICY INNOVATIONS.....	13
RECOMMENDATION 1: HAVE CONCRETE AND CONSISTENT GOVERNMENT POLICIES ..	13
RECOMMENDATION 2: CREATE GREEN BANKS	14
RECOMMENDATION 3: EXPAND PUBLIC AND PRIVATE “MARKET PULL” PROGRAMS	15
RECOMMENDATION 4: LEVEL THE REGULATORY PLAYING FIELD.....	17
RECOMMENDATION 5: COORDINATE AGRICULTURAL AND RURAL DEVELOPMENT PROGRAMS TO ENHANCE INDUSTRY AND SOCIAL INFRASTRUCTURE	18
RECOMMENDATION 6: TAKE ADVANTAGE OF EXISTING INFRASTRUCTURE.....	18
CONCLUSION.....	19
APPENDIX.....	21
ENDNOTES	23

The biobased products sector brings together two of the most important economic engines for rural America: agriculture and manufacturing.

—USDA Secretary Tom Vilsack

Introduction

In much the way that high oil prices and concerns about climate change have spurred the development of renewable fuels, the same challenges have produced a surge of public and private interest in bio-based alternatives to petrochemicals. Bio-based chemicals, derived from plants, algae, and organic waste rather than petrochemicals, offer potentially major economic and environmental benefits. With the tools of biotechnology, agricultural-based feedstocks can in principle replicate the vast array of petrochemicals now used to make plastics, textiles, building materials, and countless other products that permeate modern life.

The potential opportunities are huge. Ninety-six percent of all U.S. manufactured goods use some sort of chemical product, and businesses dependant on the chemical industry account for nearly \$3.6 trillion in US GDP.¹ The annual market just for polyethylenes, which are used to make plastics, is more than 100 million tons.² Supporters say many renewable-based plastics can be cost competitive if oil prices remain above \$60 a barrel, as they are now and are likely to remain.³

For the United States, bio-based chemicals can reduce dependence on imported oil, curb emissions of greenhouse gases, and open up new opportunities for farmers and rural communities. Using genetic engineering and the older science of organic chemistry, manufacturers could fine-tune their plant-based products to offer longer endurance, new performance attributes, and greater biodegradability.

The emerging industry presents opportunities for rural America. The United States is the world's leading agricultural exporter. Bio-based chemicals offer the prospect of new cash crops like switchgrass, new demand for the cellulosic fiber in traditional crops, and new jobs in bio-chemical production and processing.

In April 2012, the Milken Institute, with support from the U.S. Department of Agriculture, hosted a Financial Innovations Lab on ideas to spur this industrial side of biotechnology. Participants included leading scientists, senior government officials, industry executives, institutional investors, and venture capitalists.

In an intensive brainstorming session, participants on all sides agreed that the business case for bio-based products is growing stronger every year. Coca-Cola is investing heavily in "green" bottles. SC Johnson, manufacturer of household cleaning products such as Pledge and Windex, has created its own "Greenlist" to rate the environmental impact of actual and potential ingredients in its products. The company says it has increased the share of "best"-rated compounds over the past decade from 4 percent to 27 percent of its total ingredients.⁴



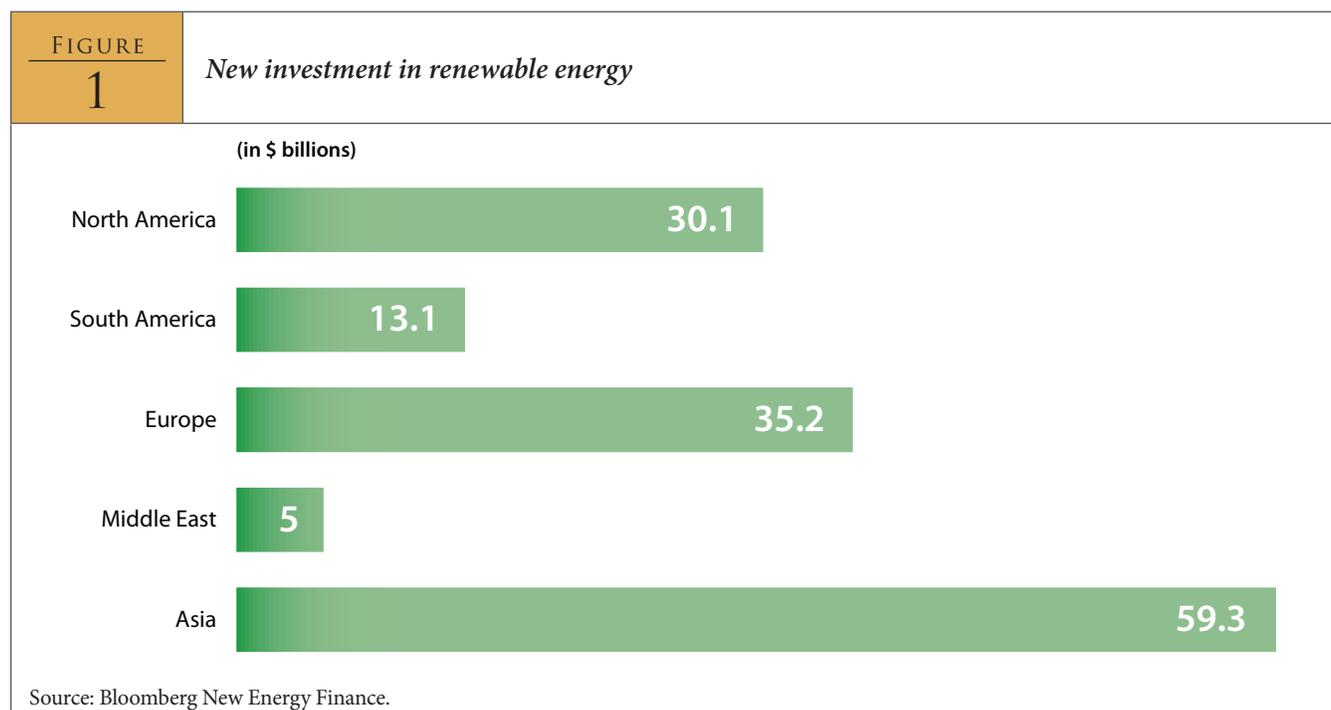
More and more consumer goods are going green.

Photo: Courtesy of NatureWorks LLC.

But Lab participants also identified formidable financial barriers: long gestation periods for new products, intimidating competition from petrochemical producers, and daunting capital requirements to bridge the gap between laboratory-level proof-of-concept and commercial production. Lab participants proposed a wealth of recommendations, from innovative financing mechanisms to ideas for stimulating demand for new products.

The April Bio-Economy Lab was a follow-up to one that Milken and USDA hosted in 2010, and much had happened in the intervening years. Several young bio-based companies have raised more than \$100 million apiece through initial public stock offerings. Multinational chemical companies, including Dow, DuPont, and Mitsubishi Chemical, have expanded their partnerships with startups. Foreign commercial activity, notably in Brazil, has accelerated.

But participants generally agreed that the barriers remain high, especially in the United States. Indeed, a growing number of technologies conceived in the United States are being scaled up for commercial development in Brazil, China, Thailand, Indonesia, and Europe. Asia and Europe are out-investing the United States in renewable energy (see figure 1). The United States could miss important new markets, despite having started with a technological edge and a comparative advantage in agriculture. China's late but spectacular rise in solar panels, in which it is now the world's dominant player, may offer a sobering precedent.



Lab participants agreed that the United States could replace about 20 percent of petrochemical consumption with bio-based products over the next decade, and in doing so capture a significant portion of the global renewable chemical market. That would require as many as 10 commercial-scale bio-production plants, which would in turn require about \$50 billion in capital.⁵ Given the intense budget pressure in Washington, participants agreed almost all of that money would have to come from private investors. But most saw a need for the government to share some of the financial risk and to spur demand, especially if this new industry can create much needed jobs and economic growth.

The participants' most ambitious proposal was for a new array of "green banks" to finance small, experimental projects and commercial-scale facilities for proven technologies. Private investors would take the upfront financial risk by absorbing first losses of up to 10 percent of the loan portfolio, but the government would backstop the rest. By assuming significant upfront risk, private investors would have strong incentives to properly vet the new technologies and "de-risk" them.

The Lab sessions also produced a variety of other proposals. Among them:

- Expanding efforts to create more "market pull" for bio-based products;
- Leveling the regulatory playing field, which currently exempts petrochemicals from the environmental and health reviews imposed on new chemicals;
- Reducing scale-up costs by making better use of existing infrastructure;
- Marshaling and coordinating the full array of current agricultural programs, from those that finance research to those that support rural development, to create the infrastructure for bio-based businesses.

"The technology is here, it's ready," said William Tittle, director of strategy at Nexant, a software and consulting firm focused on renewable fuels and chemicals. If it does not take root in the United States, it likely will somewhere else.

Issues and Perspectives

INDUSTRY OVERVIEW

Biotechnology is often divided into color categories: “red” for pharmaceuticals, “green” for agriculture, “blue” for marine science, and “white” for industrial chemicals. The 2012 and 2010 Milken Financial Innovations Labs on the bio-economy have focused on the “white” biotechnology: chemicals derived from plants, algae, bacteria, and other organisms that can replace chemicals derived from petroleum and natural gas.

In principle, plants and microorganisms can produce the same chemicals as petroleum and natural gas feedstocks, as seen in figure 2. Those chemicals reach every corner of life: plastic bottles and packaging, nylon and polyester fiber, flavors and fragrances, cosmetics and personal care products, and building materials and insulation.

FIGURE
2

Moving from molecules to products



Though petrochemicals account for only about 3 percent of petroleum production, bio-chemicals could reduce dependence on imported oil and exposure to volatile energy prices. Bio-based products can often be produced with less energy, and sometimes at lower cost. Over their entire lifecycle, from production through disposal and breakdown, many produce no net increase in carbon dioxide or other greenhouse gases. Beyond those potential environmental benefits, bio-chemicals offer new economic opportunities for farm communities in crop production and chemical processing.

Between 50 and 100 companies are now in, or trying to enter, a slice of the market.⁶ Young firms like KiOR are making crude oils from wood chips and switchgrass;⁷ Solazyme is making plant-based specialty oils that it says are one-third cheaper than comparable fossil fuels.⁸ Other high-profile startups are working on intermediate and specialty chemicals. BioAmber produces succinic acid, used in polyurethane, food additives, cosmetics, personal care products, and pharmaceuticals.⁹ Genomatica is producing butanediol, used in spandex and urethane foam; Cathay Industrial Biotech, a Chinese company, is producing chemicals used in nylon, lubricants, solvents, and pharmaceuticals.

Bio-based products face an uphill battle. Petrochemical producers have the benefit of fully amortized refineries, economies of scale, reliable supply chains, and longstanding customer relationships. The new entrants have to prove their technologies, establish factories with economies of scale, and convince industrial customers that the new products are cheaper or better than the old ones.

Unlike new, genetically engineered pharmaceuticals, which usually enjoy patent monopolies and sometimes command stratospheric prices, most bio-based chemicals are “drop-in” substitutes for chemicals already in use. Success requires competing on cost, which in turn requires producing at big factories with full economies of scale. That creates a classic “valley of death” for financing: High-risk venture capitalists don’t want to finance big refineries that pay off slowly over 10 or 20 years; banks and bond investors don’t want to take on projects with technology risk.

Adding to the challenge, biotechnology is regulated by three agencies with occasionally conflicting missions—the Department of Agriculture, the Environmental Protection Agency, and the Food and Drug Administration. The complexity creates uncertainty about current and future regulation, which can dissuade investors and businesses. Indeed, new bio-based chemicals often have to undergo intensive regulatory scrutiny for possible risks to health and the environment. Most conventional petrochemicals, by contrast, are exempt and never face such reviews.

To be sure, the industry has made progress since the Financial Innovations Lab in 2010. The most striking indicator of progress is that several young companies have been able to raise more than \$100 million apiece through initial public stock offerings or private placements (see table 1).

But the window for bio-based IPOs essentially closed in late 2011 and early 2012, as shares in most of the companies fell below their opening prices. Several firms postponed or canceled plans for public stock offerings, with some raising money through private placements. Even if stock prices had remained strong, however, the companies would have had to line up far more money to build operational commercial plants.

Participants in the Lab identified a number of continuing barriers to the financing of research and development and to commercial scale-ups. Most participants agreed that overcoming those barriers would require support from the federal government.

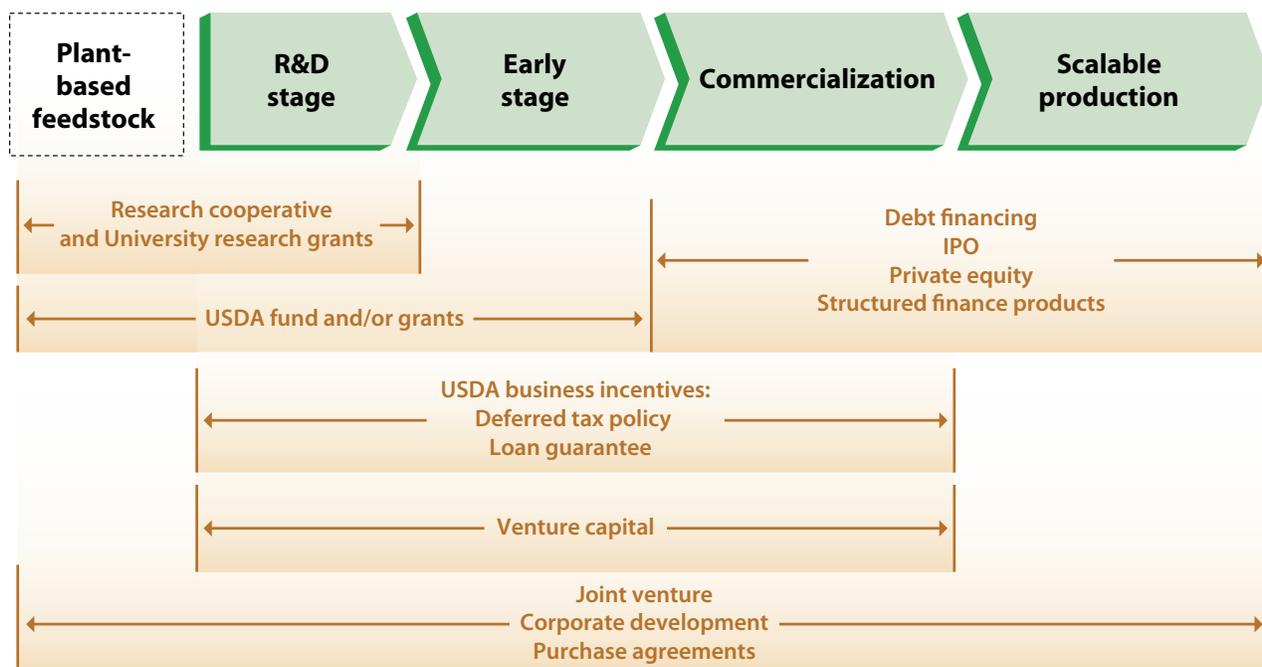
TABLE 1		<i>Selected industry IPOs</i> ¹⁰	
Company	IPO	Filing Date	Product Description
Codexis	\$78 million	December 2009	evolved biocatalysts
Amyris	\$84 million	September 2010	isoprenoids
Gevo	\$107 million	August 2010	isobutanol
Solazyme	\$227 million	March 2011	plant-based oils
KiOR	\$138 million	April 2011	crude oil from wood chips and switchgrass
Myriant	\$150 million	June 2011	succinic acid
Elevance Renewable Science	\$100 million	September 2011	specialty chemicals from biomass-based oils, including soybean, palm, and rapeseed (canola) oil
BioAmber	\$150 million	November 2011	bio-succinic acid

INDUSTRY BARRIERS

BARRIER 1: BRIDGING THE READINESS GAP

The gestation period for new bio-based chemicals is five to 10 years—longer than most investors can tolerate without revenues or profits. Venture capitalists and risk-oriented equity investors may be willing to wait several years, but they have not been willing to put up the billions of dollars needed for commercial scale-up. Banks and bond investors have traditionally financed big projects that offer modest but predictable annual returns over many years, but they do not want to take on technology risk or untested markets.

Bio-chemicals face an additional financing challenge because the most expensive research and development occurs at the start of the supply chain. The main challenge is to convert unconventional feedstocks, like cellulosic fiber from wood or grass, into the basic building blocks for advanced chemicals. But these early-stage conversions produce the simplest and cheapest commodity chemicals, and it is difficult if not impossible for most startups to make a profit on them. Intermediate and advanced specialty chemicals are more lucrative, but the only way to create bio-based versions of the existing products is to have the relatively unprofitable building blocks. Put another way: Once a company has cracked the problem of creating bio-based commodity chemicals, it may not have much competitive advantage higher up the value chain (see figure 3).

FIGURE
3*Stage-oriented funding mechanisms*

Source: Milken Institute

The new chemicals and products need to compete on price and performance against well-established petrochemicals, which are produced in fully amortized plants with full economies of scale. A commercial-scale chemical plant can cost \$5 billion or more. Richard Dove, founder of Adamas Energy Investments, estimated that it would require 10 full-sized bio-chemical plants costing a total of \$50 billion for bio-based products to capture 20 percent of the market now served by petrochemicals.

Projects of that scale are typically financed with syndicated bank loans or long-term bonds, which promise lenders modest returns at low risk. Biomass chemical plants, by contrast, pose both technology and market risks. Even technologies that show great promise in the lab remain unproven as business propositions if they have not been produced in large volumes.

“Even companies with \$100 million in the bank from IPOs can’t get debt financing for new plant construction,” said Michael McAdams, senior policy advisor on fuel issues at the law firm of Holland & Knight.

Long construction times pose a risk, given that the technological landscape and the market outlook can change dramatically during the years that it takes to bring a new plant on line. Supplies of alternative energy sources increase and decrease, based on a variety of economic, environmental, and governmental factors, which affect prices and demand. The plunging price of natural gas in recent years, for example, could make natural gas liquids more competitive as feedstocks for petrochemicals.



Scaling up production of bio-chemicals requires significant, long-term investments in infrastructure.

“In the end, the risk for all of these production-scale projects is the construction period and whether they can get through the construction period and the de-bottlenecking period to get to the point where they’re actually producing at scale,” said Chris Groobey, a partner specializing in financing for clean-energy projects at the law firm of Wilson Sonsini Goodrich & Rosati. Once production has been proven at scale, he said, “many people would be thrilled to lend to them.”

BARRIER 2: PERCEIVED MARKET UNCERTAINTIES

High expectations fueled a boomlet of investor excitement in 2010 and 2011, when a handful of young companies raised hundreds of millions of dollars combined through initial public offerings and large private placements. The excitement has faded somewhat, amid questions about the actual environmental benefits, based on life cycle analysis of many of the end-products, and uncertainties about cost competitiveness.

However, petrochemical companies, which have vast infrastructure already in place, can and do form partnerships with young biomass-based companies. But William Tittle said they have put more money into their existing product lines.

“I feel that the multinational chemical companies, the big companies, the Dows, the DuPonts, the Shell Chemicals and BASF...have generally been very cautious with regard to committing to this technology, and the reason is that it often cannibalizes their existing business,” Tittle told participants.

Risk-aversion toward bio-based products is not limited to banks, bond investors, or existing petrochemical companies. Archer Daniels Midland, the agrichemical giant, recently abandoned a high-profile joint venture with a young biomass company, Metabolix, to manufacture and market bio-plastics. ADM, which booked a \$300 million charge against earnings on the joint venture, said Metabolix’s fermentation technology had “performed well” but cited “uncertainty around projected capital and production costs, combined with the rate of market adoption.”¹¹ ADM’s announcement had a depressing effect on many other aspiring bio-based companies. Those that had already gone public saw their stock prices drop. Several prominent young companies have had to postpone public stock offerings.



Scaling up production of bio-based chemical products requires the construction of new refineries. They can cost millions of dollars but can also trigger significant economic growth for local communities.

BARRIER 3: POLICY UNCERTAINTY AND COMPLEXITY

The federal government has a long tradition of fostering new technologies and industries, whether by funding basic research in the life sciences, offering loan guarantees and tax incentives, using its purchasing power to jumpstart new markets, or developing new infrastructure, such as the Global Positioning System, and letting entrepreneurs build businesses around it.¹²

Yet the regulation of bio-based chemicals is complex and sometimes more onerous than rules governing petrochemicals. Chemicals derived from biotechnology are regulated by the Environmental Protection Agency, the Department of Agriculture, and the Food and Drug Administration, with older products grandfathered in. A single bio-based chemical can be subject to regulations at more than one agency, making compliance with the law complicated, uncertain, and expensive—especially for startups.

The Obama Administration and Congress have supported a variety of federal programs to promote bio-based chemicals. The assistance takes many forms: tax incentives, advanced crop research, and the USDA's BioPreferred program, which instructs most civilian government agencies to buy bio-based substitutes over conventional products if the renewable products meet performance and price requirements. The USDA and Department of Energy also offer research grants and loan guarantees, although they are limited in scope. And the Defense Department has pushed hard to spur biofuels, which use the same feedstocks as bio-chemicals.

Funding for such programs is becoming increasingly scarce, however, and it is likely to become even more so. With annual federal deficits still near \$1 trillion and public skepticism toward government spending high, lawmakers in Congress have been pushing to cut financial assistance wherever possible. Appropriations for new programs are almost impossible to push through Congress. Several existing programs, such as the Biomass Research and Development Initiative and Biomass Crop Assistance, are up for renewal in the 2012 farm bill that will fund "mandatory" programs, from food stamps to farm subsidies, for the next five years.¹³ But the future of

even those programs is precarious. House Republicans pushed to eliminate all energy provisions in the farm bill, while the Senate's version of the bill would reduce them only slightly. As of late summer, Congress had not resolved the disagreements.¹⁴ Congress has been embroiled in similar fights for years over extending tax incentives for wind power and other forms of renewable energy, often wreaking havoc on those industries. The unpredictability sends a signal of "ad hoc-ism" to investors and creates yet another barrier to investment.

Even when Congress does fund programs to spur activity, the legislation and implementing regulations can create disincentives. Tradable production tax credits can be a valuable financing tool for start ups, because the tax credits can serve as a form of cash flow to investors even before a company generates profit. But Dovert of Adamas Energy Investments warned that there is a possibility that the Internal Revenue Service could "claw back" the tax benefits if a technology later fails. The risk of such claw-backs, often years after the benefits are received, can prompt otherwise willing investors to stay away.

Even programs intended to support bio-chemicals have surprising restrictions. The USDA's Biorefinery Assistance Program (Section 9003), for example, offers partial guarantees for loans of up to \$250 million.¹⁵ But the program is only available to refineries at which a majority of the production is advanced biofuels.¹⁶ Bio-based chemicals are often a natural complement to bio-based fuels, just as petrochemicals often are for oil and gasoline products, but the two businesses do not always overlap. As a result, the biofuel requirement, embedded in the legislation passed by Congress, may have had the unintentional outcome of excluding many bio-chemical ventures that do not produce fuels.

State governments, particularly in agricultural strongholds, sometimes offer their own incentives to new biomass companies. But negotiating with multiple state governments, each with its own packages and agendas, can be a very expensive route toward financial assistance. Companies routinely spend hundreds of thousands of dollars on environmental assessments, with separate ones required for each state that offers a plausible package of benefits. For any state bond issue, companies have to coordinate discussions between state officials, investment bankers, and attorneys. If a company is negotiating with more than one state at a time, warned Ally LaTourelle of BioAmber, "the inefficiencies are exponential....Once we get into one or even two mechanisms used at the same time on these projects, it becomes financially infeasible for a company that's starting out."

Financial and Policy Innovations

RECOMMENDATION 1: HAVE CONCRETE AND CONSISTENT GOVERNMENT POLICIES

At the Financial Innovations Lab, senior USDA officials outlined several programs aimed specifically at fostering both biofuels and bio-chemicals. The Biomass Research and Development Initiative, a joint effort of the USDA and the Department of Energy, provides research grants for work on bio-based feedstocks, fuels, and chemicals. But the program is small—\$35 million over the next three years—and future funding will depend on how Congress deals with the 2012 farm bill.¹⁷

Recommendations for Policy Actions

Farm bill:

- Include language to incorporate the bio-chemical industry in section 9003 (Biobased Product Manufacturing)
- Include legislation to establish renewable chemical production tax credits

Department programs:

- Open up current grant programs within the Department of Energy, such as from the Advanced Manufacturing Office and the Advanced Research Projects Agency–Energy, to include the renewable chemical industry
- Expand the scope of Department of Agriculture programs, for example, the Biomass Research and Development Initiative, to include higher-value bio-based chemicals

Participants in the Financial Innovations Lab agreed that private investors have to take much of the upfront risk. But many also argued that the government will have to play a significant financial role from the experimental to the commercial development stages. A recurring theme among many participants was that much scaling-up work is now taking place in other countries, notably Brazil, where governments have made bio-chemicals a strategic priority and are providing important incentives.

Some of these countries are able to provide better incentives and capital packages to industrial biotech companies because of this strategic priority and some because state capitalism allows them more flexibility to create new industries. However, regardless of context, these countries are luring successful technology companies to build commercial scale plants abroad. Consequently, a plant that could have provided rural Mississippi a hundred high-paying jobs, millions of dollars in municipal tax revenue, and much needed community investment will now lose to Asia or South America.

“Some people around the room have very specific stories of bankers sitting around the table, saying they’re not going to take the technology risk unless there’s a government guarantee,” said Corinne Young, a lobbyist for manufacturers of renewable chemicals and materials. “Other countries and sovereign nations are stepping up because they want these high-paying, full-value-chain jobs....You have Thailand throwing companies tax abatements for the life of the project, and you have Canada throwing \$30 million in grants and zero-interest loans, and Indonesia offering tens of millions of dollars.”

Lab participants had different views of which policies would be most effective, but many argued that policy predictability was as important as the substance.

“We need to be consistent with our policies, whether it’s RFS (the EPA’s Renewable Fuels Standard), or whether it’s looking at even opening loan-guarantee programs to renewable chemicals,” said Rina Singh of the Biotechnology Industry Organization. “The risks [for private-sector firms] become very, very high.”

RECOMMENDATION 2: CREATE GREEN BANKS

Perhaps the most daunting challenge for renewable chemicals is obtaining long-term financing for refineries and plants that produce at high volumes. “Bio-refineries need to be built to last forever, so they need long-term, stable financing,” said Alan L. Boyce, president of Adecoagro, a diversified agricultural production company with operations in Argentina, Brazil, and Uruguay.

Boyce outlined a broad proposal, based on practices honed in Denmark, for a system of “green” banks that would sell standardized, transparent bonds to finance loans for commercial-scale production biofuels and bio-chemicals. Standardized bonds, similar to bonds backed by plain-vanilla home mortgages, make it easier to create broad liquid markets and obtain lower interest rates.

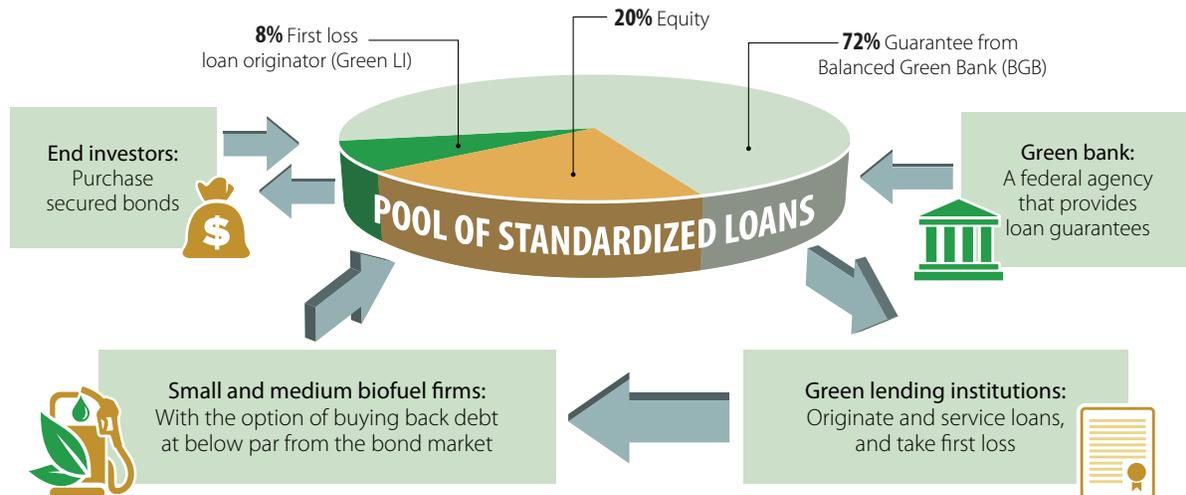
Because bio-based refineries pose technological and market risk, the green banks’ bonds would be guaranteed in part by the federal government. To protect taxpayers, private fund managers and investors would have to absorb the first losses—up to 10 percent of the total portfolio. By having “skin in the game,” green-fund managers would have a strong incentive to carry out rigorous risk analysis (see figure 4). The government would act as a reinsurer, with its guarantees taking effect only after private investors had absorbed substantial losses.

To encourage a liquid secondary market for green-bank bonds, which would reduce investor risk and keep rates low, Boyce argued that the loan arrangements should be standardized and come in only four or five variations. The green banks would not try to create customized financing plans for each project; instead, developers would have to tailor their projects to one of the four or five plans.

Richard Doveve proposed an additional refinement to help finance smaller but riskier early-stage demonstration projects. In their simplest form, however, the standardized green bonds would only be appropriate for financing production plants with well-established technology and relatively low risk. To help bridge the “readiness gap,” which requires scaling up production, Doveve and other participants proposed that the fund managers reserve a small portion of their portfolios for riskier proof-of-concept projects. Those high-risk projects would be charged higher interest rates, and the potential losses would be limited to a small share of the total portfolio. The higher risk would be offset in part by higher rates and fees, but could also be spread over the broader portfolio.

FIGURE

4

Green lending structure

Source: Alan Boyce.

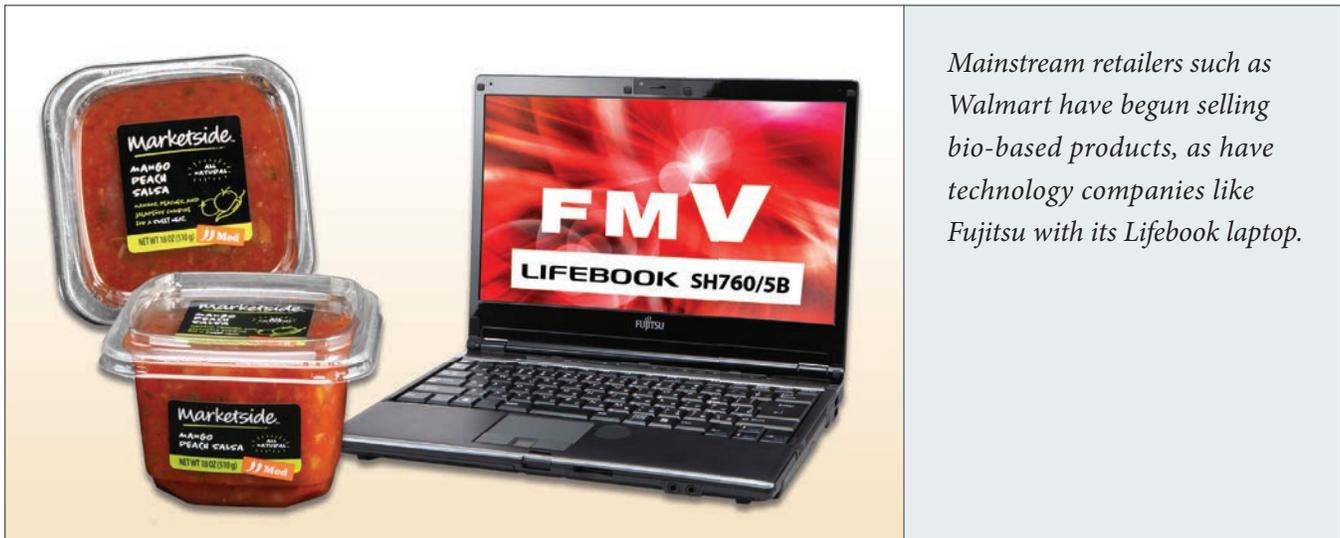
“You could allocate \$100 million of a \$1 billion portfolio to experimental projects,” said Evan Stampler, an agribusiness analyst at Goldman Sachs. “You assume that half of experimental projects fail, but the remainder of the money is lower risk. You raise money at 3 percent, charge higher-risk borrowers 6 or 8 percent, (which would be) better than not getting a loan at all.”

RECOMMENDATION 3: EXPAND PUBLIC AND PRIVATE “MARKET PULL” PROGRAMS

In addition to nurturing the supply side for renewable materials and products, policymakers and the industry itself can boost demand through “market pull” initiatives.

One particularly visible example for bio-based fuels and chemicals is the USDA’s BioPreferred program. Established by Congress under the 2002 Farm Bill and expanded under the 2008 Farm Bill, the BioPreferred program has two main pillars.¹⁸ The first is a mandate to most civilian agencies to give a preference in procurement for bio-based products over those based on conventional petrochemicals. The second pillar is a certification and voluntary labeling system, which sets the definition of qualified “BioPreferred” products in 77 categories.¹⁹

The BioPreferred categories, finalized in July 2011, range from building materials and industrial chemicals to disposable tableware, printer inks, and skin-care lotions. The minimum required share of biomass content varies widely across categories, depending on the characteristics of products in each category. But the system now gives bio-based producers a preference in government procurement and, if they want, a label with which to promote their products in the marketplace. More than 10,400 specific products for preferred procurement are now certified under the program.²⁰



Mainstream retailers such as Walmart have begun selling bio-based products, as have technology companies like Fujitsu with its Lifebook laptop.

Photo: Courtesy of NatureWorks LLC.

Wrangling over certification rules has been endemic since the program began, and it is likely to continue. The current standards took many years to develop after extensive debate among stakeholders. However, it's clear that the metrics should be consistently refined to maximize the impact on manufacturers and consumers as the market grows and industry performance becomes more standardized. Roger Conway, principal at Rosslyn Advisors, suggested that the market will be less concerned with content than with performance, a measurement that is not entirely captured in the BioPreferred labels. "If you have something that's 50 percent or 60 percent (biomass) that's highly expensive (and) that's not meeting the performance criterion, then it's a wasted product," Conway said. In contrast, he said, a company like Archer Daniels Midland might have a cheaper product that performs well and is just 20 percent biomass. A core goal of the BioPreferred label is to spur awareness and demand for bio-based products, but as yet there is no platform for consumers to easily access information on performance metrics. Participants debated the best options to market this information, both within the current BioPreferred framework and through alternative assessment programs.

Labeling and certification programs do not have to originate with the government. The U.S. Green Building Council, an industry-backed accreditation group, created the LEED certification system for sustainable buildings. SC Johnson, manufacturer of household cleaners such as Pledge and Windex, has developed its own "Greenlist" for component chemicals. The International Organization for Standardization (ISO), which develops product standards largely on the basis of industry input, has developed its ISO 14000 family of environmental management standards, including its 2011 standard to reduce the environmental impact of products and services.²¹

There are limits to the marketing value of "green" labeling. William Tittle of Nexant cautioned that most bio-based products cannot command a "green premium," or higher price, simply by virtue of being made from renewable components or being biodegradable. Marvin Duncan, a senior agriculture economist at the USDA, said automobile industry executives have been largely indifferent to the origin of their supplies. "While interest in biobased products is improving, the nexus of price, performance and measureable environmental sustainability will also be the premier factors when comparing products."

Other Lab participants said the consumer appeal of goods made with renewable products is indeed increasing. Consumers may not be willing to pay a green premium, but they may give the edge to products made with renewable materials and environmental attributes and equivalent performance if the price is no higher. That is a major reason why Coca-Cola is investing heavily in “green” bottles made from bio-plastics, and why companies like SC Johnson are eager to establish their environmental bona fides.

Participants in the Lab discussed using insurance to reduce technology risk enough to attract long-term debt financing from banks or bond investors. For example, participants broached the idea of technological risk insurance to increase the bankability of long-term advance-purchase contracts, in which the government or a large corporate customer commits to buying specific amounts of a bio-based product at specific prices. This practice is currently used, for example, in Germany in the geothermal industry to mitigate risk of failures to find new resources.

But several participants were skeptical that insurers would be willing to take the financial risk out of technology without demanding prohibitively steep compensation.

“Sadly, the people best placed to take tech risk are on the equity side—because they know more about this than anybody else,” said Dovere, whose firm specializes in alternative energy. “If you put that risk on somebody else, they’re going to charge a huge sum that’s going to make it look like equity.”

RECOMMENDATION 4: LEVEL THE REGULATORY PLAYING FIELD

Government policies often give one industry a non-market advantage over rivals. One possible case study affecting bio-based products is the Toxic Substances Control Act (TSCA), under which the EPA regulates the manufacture and sale of chemicals. Passed in 1976, the TSCA requires the EPA to protect the public from “unreasonable risk of injury to health or the environment.”²² As a practical matter, however, the law essentially exempted most chemicals that were in use at the time it was passed. There are a handful of exceptions, such as polychlorinated biphenyl products or PCBs, but tens of thousands of long-used chemicals are effectively exempt from fresh scrutiny. By contrast, companies must submit all new chemicals for EPA review. If regulators find that a new substance poses a risk to health or the environment, they can subject it to tight restrictions and even prohibition.

“These new [chemical] applications get intense scrutiny,” said Ally LaTourelle of BioAmber, arguing that the Toxic Substances Control Act gives conventional petrochemicals a huge advantage over products made from biomass due to the exemption of existing chemicals to the reevaluation. “Startup companies in this new technology are sometimes required to do life-cycle analysis, adding to the hundreds of thousands of dollars for everything else, and yet petrochemical companies can still withhold their information under TSCA. They do not have to report it under a business secrets umbrella. They do not have to prove that their products are safe.”



Photo: Courtesy of NatureWorks LLC.

Lawmakers and industry players on all sides may have a practical reason to develop a more uniform approach. In the absence of federal regulation, individual states may start regulating themselves. Many states, most recently California, have passed laws banning the plastic BPA from use in baby bottles and sippy cups.²³ If states create a regulatory patchwork, both existing and new producers could be more restricted than they might be with uniform nationwide regulation.

RECOMMENDATION 5: COORDINATE AGRICULTURAL AND RURAL DEVELOPMENT PROGRAMS TO ENHANCE INDUSTRY AND SOCIAL INFRASTRUCTURE

Beyond initiatives created specifically to promote renewable chemicals and fuels, the Department of Agriculture offers many other programs that can indirectly support the new industries. A bio-based chemical processing plant, for example, is likely to prompt an influx of factory workers and white-collar professionals who will in turn require expanded schools, health care, social services, and physical infrastructure. The USDA's Community Facilities Program can play a pivotal if indirect role by providing grants and loans for health clinics, schools, vocational centers, police stations, and a wide variety of other public buildings for rural communities. Likewise, the Rural Energy for America Program (REAP) offers loan guarantees for renewable energy and energy-efficiency projects.²⁴ Neither program can provide money for fledgling bio-based chemical ventures, but both can free up local money for tax incentives and infrastructure that improve a community's ability to entice the new industry.

Indirect support of that nature is important, because the first and sometimes later stages of converting agricultural feedstocks into bio-chemicals are often best done near the farm site. Plant-based biomass is "fluffy," meaning that it has low density and occupies a great deal of space. That makes it comparatively cumbersome and expensive to transport. Rural communities thus have another opportunity to generate jobs and growth by providing the chemical processing as well as the crop cultivation.

Rural states and communities are eager to offer financial incentives for bio-based producers, but those incentives can drain scarce money for education, health, and other local priorities. One way to free up money, however, is for communities to make better use of rural development programs that do not have any direct link to bio-based production.

RECOMMENDATION 6: TAKE ADVANTAGE OF EXISTING INFRASTRUCTURE

By far the biggest obstacle to development of bio-based products is the need to "de-risk" technology by proving its commercial viability at steadily higher production volumes. Startup companies have little opportunity to raise the necessary money, but they can piggyback on the infrastructure of existing chemical companies and take over idle facilities. Biomass companies may be able to retrofit unprofitable ethanol plants, which are scattered through corn-growing regions.

To be sure, several Lab participants cautioned that large multinational producers of petrochemicals are leery about cannibalizing their current product lines. But most of the big players also have partnerships with young bio-based firms: Dow Chemical is working with Solazyme and Elevance;²⁵ DuPont and Mitsui are working with BioAmber;²⁶ Mitsubishi Chemical is working with Genomatica.²⁷ Indeed, bio-based startups can take a lesson from the beer industry, where legions of microbreweries lease production capacity from the giant established brewers.

Conclusion

The United States is a world leader in technology and agricultural prowess, which puts it in a powerful position to capitalize on the vast potential of bio-based alternatives to petrochemicals. The potential markets are huge, given the importance of petrochemicals in industrial economies. Advances in converting cellulosic feedstocks, such as cornstalks and switchgrass, as well as in using algae and organic waste, mean that bio-based products do not have to drive up prices for food crops like corn or sugarcane.

Plant-based renewable products could reduce U.S. dependence on foreign oil and provide a major new source of economic growth and high-paying jobs to rural America. The environmental benefits could be profound: expansion of environmental products with enhanced sustainability, and increased biodegradability, potentially reducing the need for landfills and incinerators.

Unfortunately, the United States may already be falling behind trading partners in developing new, commercial bio-based facilities. Canada, Brazil, China, and other nations are using government incentives to ramp up commercial development of bio-based plastics, fibers, and chemicals. In many cases, they are working with American companies and American technologies.

The United States does not need to create new subsidies for bio-based products. A growing array of evidence suggests that many bio-plastics can be cost competitive against petroleum-based rivals. But many bio-based products need to bridge the gap between laboratory demonstrations and commercial viability. Government can create “market pull” for new products with its vast purchasing power. The USDA’s research programs can help “de-risk” new crops for better and cheaper feedstocks and improve supply-chain development. Existing rural development programs can help farm communities create the social and physical infrastructure for bio-processing industries. Regulators should level the playing field between petrochemicals and renewable substitutes.

Finally, the federal government can use innovative financial structures, including partial loan guarantees, to mobilize private capital with minimum risk to taxpayers. Private investors have to shoulder the big risks and come up with most of the money. But consistent and coordinated policies can remove unnecessary barriers and lay the foundation for a market-powered transition to the future.

APPENDIX

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