

Biofuel Commercialization Risks: Myths, Truths and Solutions

Energy Commercialization Workshop Series



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Conference Insight Report

The Energy Commercialization Workshop Series

Overview

*The **Energy Commercialization Workshop Series** is a joint effort between the Renewable and Sustainable Energy Institute (RASEI) and ColoradoEnergyNews.com. The program is designed to assist industry participants to better understand the current market dynamics and discuss best practices for commercializing new solutions and technologies in the cleantech industry.*

Each workshop engages stakeholders and experts from a specific industry (solar, wind, biofuel, building efficiency, geothermal and more). The format features a moderated panel discussion in which participants discuss existing market trends, identify top barriers and risks to commercialization success, and methods for dealing with and overcoming those risks.

The first workshop focusing on biofuels was held at the Ritz Carlton in downtown Denver last fall. The event engaged experts across business, technology, agriculture, public policy and the investment community. The major risk areas (feedstock, high capital requirements, uncertain policy and technology scale up) were discussed and best practice strategies shared from multiple viewpoints.

The Energy Commercialization Workshop Events are hosted by:



Trent Yang, Director of Entrepreneurship and Business Development, University of Colorado, Boulder's Renewable and Sustainable Energy Institute (RASEI)

RASEI is a joint research institute between CU-Boulder and the National Renewable Energy Laboratory (NREL). As director of the RASEI's business arm, Trent's focus is to expand engagements with the business community to encourage rapid commercialization, joint research, entrepreneurship, increased interaction between the business and research community and opportunities for working with students at CU-Boulder.

Trent has been active in the cleantech space as a policy analyst, investor, entrepreneur and academia director for almost a decade. Prior to joining CU-Boulder, Trent started a cleantech company in Boston focused on water filtration. Before that, Trent worked at Globespan Capital Partners where he invested and oversaw investments in cleantech and IT start-up companies. Prior to Globespan, Trent worked at Booz Allen Hamilton where he provided strategic and management consulting to Fortune 500 technology companies and government research labs. Before joining industry, Trent spent a number of years working on climate change policies both in academia and in government.

A native of Boulder, Colorado, Trent has M.S. degrees from MIT in management, policy and engineering and an undergraduate degree from the University of Colorado in Aerospace Engineering with a minor in Economics.



David A Hill, Founding Publisher, Executive Editor of *ColoradoEnergyNews.com*

David has more than 25 years of B2B media experience, including the development of several niche market publications, conferences and websites. Prior to launching RM Media Group, LLC, and *Colorado Energy News* in 2008, he provided media consulting expertise to Fortune 1000 companies. Before that he founded and managed AES Marketing, Inc., which published award-winning publications in the industrial engineering marketplace, including *Pumps and Systems* magazine and a related trade show. Both properties were eventually sold to Randall Publishing.

A graduate of Loyola Marymount University, Los Angeles with a degree in Communication Arts, David moved to Colorado more than 20 years ago to enjoy the active, outdoor lifestyle. He currently resides in Snowmass Village, with his wife, Janine.

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Panel Speaker Bios

To lead our discussion group, we assembled a panel of experts from across multiple disciplines to offer their own unique perspectives on the biofuel industry. Panel members included:

Agriculture / Feedstock:

- **Doug Karlen, Senior Research Scientist, Iowa State University:** Professor Karlen has more than 35 years of experience in soil and agriculture management. He also recently took part in the American Academy of Sciences study on the future of biofuel in America.
- **John Miranowski, Professor, Agriculture Economics, Iowa State University:** Professor Miranowski has over 30 years of experience in agriculture economics with a USDA distinguished service honor for his work on biofuels. He was also recently part of the American Academy of Sciences study on the future of biofuel in America.

Industry:

- **Jim Imbler, President & CEO, Zechem:** Jim has more than 30 years of executive experience in petroleum refining and in chemical and trading operations. His experience includes working for firms such as Koch Petroleum, Evergreen Energy, FuelSpot, and Fuels Mgmt.
- **Steve Toon, Vice President, Engineering and Operation, OPX Biotechnologies:** Steve has more than 20 years of bioprocessing experience with Verenum, Cargill, and NREL.

Investment:

- **Corey Steffek, Senior Associate, Altira Group, LLC:** Cory has over 10 years of industry and investment experience in the fuel, catalysis, polymer synthesis, and processing industries. He is currently an investor and board member of several fuel-related companies.

Policy:

- **Michael McAdams, Founder, Advanced Biofuel Coalition:** Michael is the Policy Director for Brownstein Hyatt Farber Schreck, LLP and has over 28 years of government and public affairs experience. He is also the founder and president of the Advanced Biofuel Coalition, an organization that represents the interests of over 20 leading next-generation biofuel companies to Congress.
- **Mike Miller, Founding CClA Member, Colorado Cleantech Industries Association:** Mike has over 20 years of experience in the energy and biofuels industry. Currently he has undertaken a major Colorado study to determine the needs of the biofuel industry in the state with a particular focus on management and policy issues.

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Summary

The *Biofuels Workshop* was borne from a shared desire to identify and better understand the challenges facing companies who are trying to develop and commercialize the next generation of technologies for the biofuel industry. With experts from all stakeholders of this burgeoning new field, we not only identified the most pertinent risks for commercializing new technologies, but also some of the best practices for overcoming these challenges.

The energy industry is currently going through great changes and the gradual movement away from fossil fuels is a trend virtually guaranteed to continue. In addition to changing national attitudes toward energy, the agenda of the Federal government driving the biofuel industry forward. Congress has established aggressive targets mandating that 20% of fuel must come from renewable sources by 2020. While the growth potential for biofuels is, therefore, tremendous, no company has yet developed, scaled, and commercialized truly sustainable next generation biofuels based on cellulosic, algae or other synthetic green fuels. Currently, the main source of biofuel feedstock is corn that fermented and processed into ethanol. The processes by which this transformation occurs is highly inefficient and often even worse for the environment than burning fossil fuels would be.

► Clearly new ideas and new processes are needed to make biofuels a viable alternative to fossil fuels. The challenge is in finding the right feedstock, developing efficient processes, attracting capital investment, and figuring how to make the process profitable and sustainable. These are the questions our panel sought to answer.

RASEI and *Colorado Energy News* editors brought together national and local experts from a variety of backgrounds including policy, agriculture, business and technology, and financing to help attendees understand what the biggest risks are for a biofuel start-up operation and how a firm can overcome these challenges. Even though our experts came from different backgrounds, we quickly converged on five top risk areas facing the biofuel industry: feedstock, capital requirements, government policy, technology demonstration and scaling, and commercial production site selection.

Our panelists also considered issues surrounding carbon neutrality and carbon capture, time to market, water management and usage issues, product delivery, and commodity price risk.

A brief summary of the leading risks, and best practices for dealing with them, follows:

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Feedstock: While going beyond corn as a feedstock is a necessary step in the evolution of biofuels, it is also probably the biggest challenge for next generation biofuel technologies. There are a multitude of challenges for using alternative agriculture products as feedstock:

Cost: While current costs of many of these feedstocks are relatively low, the scale of future development necessary to achieve mass-market fuel deployment will likely increase this cost. Unfortunately, many companies (start-ups as well as larger firms) have developed business models based on current prices. While there is limited foresight on the price trends of various feedstocks, the price of highly scalable feedstock will undoubtedly rise as large-scale commercialization efforts begin in the next two-four years.

Availability/Delivery: Feedstocks are not universally available across the United States. While some feedstocks can grow in all parts of the country, there is not a single feedstock that is available everywhere. Therefore, a biofuel company would have to develop a process that could utilize different feedstocks depending on where their processing plant was located. Another option that provides an equal number of challenges is to transport feedstocks from where they are grown to where they will be processed. Transporting feedstocks is both expensive and can lead to feedstocks decomposing before they can be processed. Because feedstocks are organic matter, even if they are kept dry, they will eventually begin to break down as all organic material does. Long-term storage therefore also presents its own challenges.

Sustainability: A multitude of issues contribute to a feedstock's relative sustainability. The amount of water needed to grow the feedstock, the effect growing the feedstock will have on the soil, the amount of energy required to transform the feedstock into a biofuel, the distance the feedstock must be transported in order to be processed, and the cost of growing that feedstock instead of a food source all examples of some of the factors that a biofuel company must consider when trying to determine how sustainable their process is.

Best Practices: Much of the research being done now is aimed at trying to determine what the best practices are for biofuel production. The research spans the lifecycle of the fuel from how to most efficiently grow the feedstocks to transporting the feedstock to the processing facility, to delivery of the fuel to the consumer. Our panelists discuss many of these issues throughout their presentations.

Capital Requirement: One reason why biofuels are such an attractive option to fossil fuels is because the delivery of such fuels would be similar to the how traditional fossil fuels are delivered meaning that less research needs to be done in how to bring biofuels to consumers. With some minor adjustments, gas stations could be converted into biofuel stations to effectively deliver these fuels to the consumer. However, the plants required to process the feedstock into biofuels do not currently exist and would need to be funded through large capital investments. Because the need for capital

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investment is so great, individual venture capital firms are either unable or unwilling to provide all of the capital necessary for construction. Furthermore, since no large-scale biofuel processing plants currently exist, it is difficult for firms to demonstrate the effectiveness of their plans at scale and thus convince investors of the feasibility of their technology and process.

High capital requirement: Another issue that faces biofuel companies is how the high level of risk associated with scaling a biofuel production facility translates into their capital costs. Biofuel firms may find that unless they can demonstrate their process at a reasonable level, they will be unable to secure the financing they need in an affordable manner.

Lack of capital availability since mid-2008: Obviously, the tightening of the credit markets has led to a reduction in the amount of capital many venture capital firms have to spend on new projects. Biofuel firms are undoubtedly going to face a more difficult road when it comes to securing new financing for their projects.

Does not fit into typical venture capital model: Historically, most of the venture capital funds directed at liquid fuels have targeted oil and gas production and delivery. Many venture capital firms have no experience working with renewable energy companies and are reluctant to invest in a new industry, especially during the current economic downturn. Biofuel companies must therefore look to partner with a venture capital firm who either has experience investing in the industry or who is willing to move in a different direction with regards to their investments.

The need for a strategic partner: At a certain point in the development process, a biofuel firm will find that they are unable to raise the capital they need and that they must instead seek to partner with a larger company who can help them scale their product. These firms may be oil or gas companies since these firms have the experience and infrastructure in place to process and deliver liquid fuels. Locating these partners and creating workable strategic agreements is a challenge many biofuel firms will face.

Government Policy: At the time of the event, there was a great deal of uncertainty surrounding further government action in the realm of biofuels. The comprehensive energy bill being considered by Congress had yet to be put into its final form and until there is definitive action by Congress, biofuel and other alternative energy industries can only wait to see what, if any, effect the bill will have on the industry. In addition to the uncertainty surrounding the energy bill, the government must continue to be agnostic when it comes to biofuel technology development. It must be sure to not anoint a technology as the “winner” or the “best” technology for fear that such an announcement will stifle research into potentially more effective feedstock options. Finally, the biofuel industry is still quite fragmented and the different players must come together to develop a unified voice.

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Organizations such as CCIA and the Biofuel Coalition are working towards this goal, but much work remains to be done.

Technology Demonstration/Scale-Up: There are numerous biofuel firms that have developed successful technologies and that have been able to produce biofuel for commercial use. However, no company has demonstrated the ability to produce biofuel in the quantities that will be needed to supply an entire nation. Companies are struggling to scale their processes up to the levels that will be needed to build and operate an economically feasible biofuel plant.

Commercial Production Location: Significant questions surround the issue of where biofuel plants can and should be constructed. Unlike oil, which is mainly imported to port cities and refined on-site, biofuel feedstocks are grown in the center of the country, far away from existing refineries. Do companies build large processing plants in central locations and transport feedstock from farms to be processed in one location or do they focus on small refineries on-site at farms and then transport the biofuel that is produced to central distribution centers? These decisions must be made first before major investment is made into plant infrastructure, the construction of which will be expensive as well.

Attendee Comments ...

“The event really increased my understanding of the issues a biofuel startup faces. I think this is a good formula/format for increasing the knowledge level for the complex issues the energy market faces. Thanks for putting it together.”

Tim Bour, Executive Director, Boulder Innovation Center

“Trent --Thank you for running what was a thoughtful and substantively enjoyable discussion on biofuels. I was delighted to participate with such a fine, qualified group of panelist who gave an objective view of the challenges and opportunities for the new industry. “

Michael McAdams, President, Advanced Biofuels Association

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Detailed Discussions

The first portion of the event was devoted to exploring issues related to feedstocks.

Doug Karlen led the discussion off with an overview of the environmental issues that surround the production and cultivation of feedstocks. He made his first point very clear:

▶ ***Don't focus on using one feedstock because the feedstock "arena" is wide open.***

Doug indicated that there were more than a dozen potential feedstocks currently being researched with more potential types sure to follow. He also stressed the fact that feedstocks will undoubtedly be regionally diversified since there is not a single supply that can grow in all parts of the country.

He also addressed the issue of soil health and began by discussing soil carbon, comparing it to the shock absorbers on a car.

Without soil carbon, we will get to where we are going, that is to a place where biofuel feedstocks are being produced en masse, but the ride will not be comfortable. According to Doug, soil carbon levels have dropped over the years due to tillage and extensive soil preparation for crop growing. Growing feedstocks to produce biofuels will draw even more carbon out of soil and further degrade our soil resource.

▶ ***Any biofuel entrepreneur must be cognizant of soil carbon, nutrient balance, erosion, and run off when determining where to grow feedstocks and which can and should be used in the first place.***

The final issue that Doug addressed is the agricultural community's willingness to provide the feedstocks needed to produce biofuels. Many biofuel entrepreneurs are focusing on agricultural "waste" as a viable feedstock source. This "waste" consists of corn stalks, husks, and other leftover products that farms typically discard after harvesting. Doug pointed out that these so-called "waste" products actually play an integral role in reintroducing nutrients into the soil to help prepare the land for future growing seasons. Farmers, therefore, may not be willing to get rid of the "waste" since doing so may ultimately lower their future crop yields.

John Miranowski spoke next and addressed more challenges surrounding feedstock production, delivery, and storage. He began by reviewing the supply costs associated with providing feedstock. Purchasing one bale of corn stalks for \$50 a bale is very different than purchasing 1000-2000 tons of corn stalks each day for a 25-50 million gallon a year biofuel refinery. How farm owners will price the feedstock and how much refineries are willing to pay for the feedstock is a major question that must be answered. If a refinery enters into a contract with a supplier for a certain amount of feedstock per

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year, will growers be willing to abandon growing potentially more profitable crops in favor of meeting their contractual obligations to refineries? Any biofuel entrepreneur must address these questions.

► *The second challenge addressed is the issue of feedstock storage and delivery.*

The farmer is not going to want to deliver the feedstock to the refinery and the refinery is not going to want to pick up the feedstock, so an intermediary transportation network is going to be needed. These transporters are going to need to make a profit on their service so transporting the feedstocks over long distances is going to add to the costs of producing the biofuel.

Furthermore, feedstocks like corn stalks are only going to be readily available during the late fall after the corn is harvested. In order to produce biofuel year round from these feedstocks, storage facilities are going to be needed. Even if the storage facilities are specially designed, feedstocks are organic products that will decompose over time. A refinery can expect that even in a best-case scenario, 10-15% of the feedstock will go to waste. No matter what the conditions, the feedstocks can only be stored for so long before they will become unusable due to decomposition. One final issue John pointed out was the fact that crop yields fluctuate with the changing weather patterns. As crop yields decrease, so too will feedstock availability.

Mike McAdams spoke next and briefly outlined the issues with which the companies he represents are struggling. First, he said, there are more than 1000 biofuel companies right now all of who are pursuing different technologies. The technology pathways that are being developed, therefore, are all unique and are all in various stages of development. This led Mike to another critical issue he believes must be addressed – adaptability.

► *If a company could figure out how to create a biofuel refining process that could be easily integrated into a current ethanol refinery, there would be a huge cost savings for that company.*

In addition, he indicated that the price of any biofuel product must be low enough to compete with crude oil and gas. No matter how energy dense a biofuel product is, if it is priced too high, it will never succeed.

► *No matter how energy dense a biofuel product is, if it is priced too high, it will never succeed.*

Finally, Mike reiterated the point he emphasizes to the government officials with whom he meets: Do not pick a winner. Everyone is anxious to find the energy source that will reduce our reliance on fossil fuels, but if the public or the government picks a winner too soon, it could stifle the development of an even better technology or product down the road.

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Doug Karlen was then asked to describe how he would advise a biofuel startup to attempt to mitigate the risk associated with feedstocks. The first thing he said he would do is to advise that anyone looking to build a biofuel refinery should first do a detailed study of the availability of feedstocks and what these feedstocks will cost. Any biofuel company is going to have to figure out from where they can source their feedstock and how much it will cost to do so. He also mentioned the challenges associated with trying to contract production and delivery of the feedstocks.

► *Before a company embarks on the production of a 25 million gallon per year biofuel refinery, it will want to ensure that it can guarantee the supply and delivery of the feedstocks being used.*

One company Doug has worked with struggled to find the 300-400 farmers it would need to supply corn cobs for the 25 million gallon per year facility it wants to build. He then cited a survey that found that one-third of farmers surveyed were not willing to provide any feedstock for biofuels. Convincing farmers to supply the feedstock clearly is a challenge that must be addressed.

The second issue Doug discussed was how to control the costs of producing biofuels. So much of the demand for biofuels is going to be driven by the price of oil. Therefore, it is imperative to be able to produce the biofuels as cost-efficiently as possible because the cost to the consumer must be at or below the cost of oil. To further complicate the matter, the revisions being proposed to the Renewable Fuel Standard, called RFS2, are still being debated.

The government must enact its new policies before companies can begin the serious work of building biofuel plants and sourcing feedstocks. Finally, Doug made a quick point that the opportunity cost of land is seldom included in estimates of the cost of producing biofuels. Given the choice of growing a crop that will be used in producing biofuel or another one that will yield them higher profits, farmers will surely choose the higher-priced crop.

Two final issues were then addressed. First, *Jim Imbler* discussed the need for a sustainable energy crop and the fact that no company is going to want to move or store biomass. Therefore, in his opinion,

► *A good model is to position production close to the feedstock growing operation. This way, companies can minimize the transportation costs associated with moving the feedstocks from the fields in which they are grown to the refineries.*

Finally, *Steve Toon* made the point that the real question surrounding feedstocks is how much fermentable sugar each possesses.

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► *A feedstock may be economically and financially sustainable, but if it is low in fermentable sugar content, it is not going to be a viable option as a biofuel.*

The panel next turned to the issue of capital risk. As the sole representative from the investor side of the equation, *Corey Steffek* began the discussion by making the point that renewable energy has a great deal of private equity and venture capital funding resources. These firms are obviously concerned about returns and about meeting milestones in a defined period of time. Since the research and scale-up process can be so time-consuming, an energy company would need a broad investor syndicate that is willing to stick with the companies for the long haul. If these investors do leave, which in this economy many have been forced to do, startup firms are often left trying to figure out where else they can get funding. New investors may not be willing to take on the risks associated with investing in these companies unless milestones have been reached and the company's future looks especially promising.

Steve Toon then contributed his thoughts on capital risk and he identified a few areas where biofuel companies can trip up. The first issue relates to understanding risk and the fact that sometimes in small startups, the people in the organization are not familiar with the risks involved with taking a product to market. Problems that exist in the research and development phase do not go away when a product is scaled up.

In addition, investors often want larger returns than a company can provide and sometimes companies will promise things that they cannot deliver in order to obtain the funding they need. Finally, Steve stressed the importance of understanding the technology that is involved at all levels of production, from feedstock, to refining, to product delivery.

► *Without a firm understanding of the technology that is involved in the lifecycle of a biofuel product, a company could find itself producing a product or technique that cannot be scaled up.*

Jim Imbler echoed Steve's point about risk. Companies must focus on reducing risk as much as possible in order to make money, according to Imbler. Risk, he said, is multiplicative; even if a problem has only a 5% chance of occurring, if aligned with 10 other processes that also carry a 5% risk probability, the process suddenly becomes very risky.

Next, Corey Steffek discussed what types of financing works well in the biofuel industry. Most renewable energy companies seek funding for the research and development phase of the process. The challenge for investors is to give the company enough time to prove its technology to a given scale, but not so long that money is being poured into a dead-end technology. Investors must

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therefore create financing structures to encourage companies to reach certain milestones. Once a technology exits the R&D phase, it is time to get large companies involved. Investors cannot fund the project alone; eventually it is imperative to get a large company with experience in the space to create a strong partnering syndicate. For a biofuel company, this large firm could be a large oil and gas company since they have the experience in refining and delivering liquid fuel products.

Finally, Mike McAdams discussed the government's role in providing funding. There are two types of money that biofuel companies are seeking. The first is the \$800 million in pure grant money that the Department of Energy is working on distributing. Mike noted that thousands of companies applied for these funds so companies should not expect to get huge sums from the program. A separate loan guarantee program is a much better option for firms looking for large sums of money.

Mike then delved into a much broader examination of how government policy is driving the biofuel industry. His organization, the ABFA pushes three important messages to lawmakers:

1. Be technology-neutral to create a level playing field among all companies.
2. Do not focus your business on a feedstock that cannot be accessed.
3. Make sure tax credits event out.

Mike also discussed the various issues that are slowing up the process of developing biofuels, the most important of which is the climate change bill. He also noted that the EPA is promulgating rules that many biofuel firms do not agree with and that there are different tax credits for different types of renewable energy technologies meaning that if a firm's tax subsidy is dependent on how the government classifies the technology. Mike emphasized this point:

► *It is essential that long-term policy structures be in place. Constantly changing policies year-to-year creates too much uncertainty and must be avoided.*

Mike Miller followed Mike McAdams by reminding everyone that state and local governments also play a huge role driving the biofuel industry and must be included in any negotiation process.

John Miranowski was then asked to comment on how government policy affects the work that is being done at NREL. Previously, he said, NREL was almost exclusively working on cellulosic ethanol because the government felt that that technology was closest to market. Now, the government is moving toward a more technology-neutral platform and encouraging research into areas outside of cellulosic ethanol. Instead of mandating which feedstock is to be used, the government is now leaving the door wide open by telling NREL to start with any biomass and make a fuel out of it. Research is now focusing on what is possible instead of what is commercially viable.

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Finally, John feels that in the next four or five years, we will see a major “shake out” in the world of biofuels as some unproven or technologies or fuels that cannot be scaled up fall off the curve and others move up the curve.

The panelists were then asked how they would think about locating production plants.

► *The prevailing opinion was that the locations of a biofuel refinery will be entirely determined by feedstock availability. Co-locating is a great option, but if that is not possible, ample feedstock supply must be available in the area to support a 25-50 million gallon per year plant.*

Another option that was proposed was to create a system of distributed production. In this system, biomass feedstocks would be processed into a crude oil product near where the crop is being grown. This product would then be transported to a biofuel refinery to be processed further. This system will help to prevent having to transport and store large quantities of organic biomass to refineries thereby cutting down both on the cost of transportation and the amount of feedstock that will go to waste due to rot. This system has been opposed by some entities within the biofuel industry and is not seeing the same types of tax subsidies as have some other technologies.

Uncertainty over government policy was again highlighted as a major roadblock to locating and building biofuel refineries. The panel members felt that to help lawmakers make decisions regarding which feedstocks to support, lifecycle analyses should be done to determine the overall carbon footprint of each source of biomass. One final point was raised regarding the dynamic nature of the biofuel production process. Feedstocks, water use, soil use, effects on wildlife, and other factors are all inter-related. To look at each problem in a vacuum will lead to continued confusion and inaction in the movement towards an economy in which biofuels power a significant portion of our infrastructure.

Water issues came up next, and Doug Karlen began the discussion by pointing out that this issue has received a great deal of attention since grain ethanol had such a negative effect on water quality and required such large quantities of water. He then pointed out that even as we move towards second and third generation biofuels, growing the feedstocks will require significantly more water than processing it will. Evidence suggests that for every one gallon of biofuel produced, three gallons of water is used in the processing of the feedstock.

In addition, in order to grow enough feedstock to supply a 100 million gallon per year refinery, 120-150 billion gallons of water would be needed. Furthermore, the areas where these crops are grown are typically dry areas that may only get 10-12 inches of rain per year. To meet the 120-150 billion

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gallons needed, the land would need closer to 28-35 inches of water. The Ogallala Aquifer is already being depleted more quickly than it can replenish itself, so clearly work needs to be done to minimize the impact growing these crops will have on the land. Water use efficiency, water saving techniques, soil conservation techniques, optimal fertilizing use efficiency, and implementing site-specific management areas to focus on the soil resource are all practices that must be studied to try to solve this problem.

To begin the afternoon session, Mike Miller spoke on behalf of CCIA, the Colorado Cleantech Industry Association. He outlined the findings from a CCIA study of renewable energy companies in Colorado. The findings reinforced the opinions of the experts on the panel. Surveyed companies see a need for strong leadership on the state and federal levels and the importance of feedstock neutrality in any policy. A more detailed description of the survey results can be found on the CCIA website.

John Miranowski then went into more detail about the actual chemical process that is needed to produce a biofuel. The first point he made was that there are many different pathways and processes to produce biofuels. In the future, one may emerge as superior, but until that occurs, it is important that firms continue research into all reasonable processes. The most advanced biofuel technologies today are those that produce ethanol. According to Jim, there are no longer scale-up issues with conventional ethanol. The only question ethanol producers face is how quickly to scale-up their production.

Next, John discussed the various feedstocks that are out there and the issues surrounding choosing the right one. Sugar is the easiest thing to turn into a biofuel, but most companies in the US are focusing on starch-based feedstocks since such feedstocks are more abundant in this country. The first question a biofuel firm must ask itself is what feedstock are we using and is it a viable feedstock? Even if you have a process that can eliminate 100% of carbon, it will not matter if you do not have a sustainable feedstock. Once a feedstock is chosen, a firm must then perfect the process at a small scale first before it can be scaled up. Certain processes are harder to scale than others.

► *Fermentation is easy. If the process requires a retreatment step, it becomes more difficult because not many firms are making pretreatment equipment so any necessary machinery must be custom made.*

The challenge for many firms is that before they purchase the equipment to demonstrate how the process can be scaled up, they first must demonstrate the effectiveness of the process and of the feedstock. In many cases, the pretreatment equipment is needed to prove the scalability of the process, a conundrum that slows many firms' progress.

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An enzyme process can also be difficult because a firm must show how the process can be scaled, but in order to do so they need a large quantity of the enzyme and in some cases equipment, funding for which may be scarce until scalability can be demonstrated. The challenge with a thermo chemical process is that a firm actually has to scale down that process to demonstrate its effectiveness. A thermo chemical plant that uses coal or another fossil fuel typically uses 5000-10,000 tons of material a day. This quantity is far in excess of what would be needed or desired to work with a biofuel feedstock, so the issue is finding a plant that can handle a smaller load of feedstock material and still be able to demonstrate the process's effectiveness.

The final point that John made is that the biggest challenge a biofuel plant faces is to generate a cheap biofuel as inexpensively as possible. How a firm goes about it, whether it is by using a cheaper feedstock, a less expensive process, or a combination of both, does not matter. If you can take any part of the process and make it cheaper, you will drive the cost down and make the process more economically feasible.

Steve Toon then outlined some issues surrounding the processing of feedstocks and the types of waste that can be produced from doing so. His message was that even if you locate the appropriate feedstock, the process of converting the feedstock into a biofuel may yield unwanted waste and require additional manipulation be done to the process to eliminate these side effects.

Jim Imbler then provided some advice to new biofuel firms. His comments were focused mainly on those firms using a gasification process, but they are certainly applicable to all firms. He began by advising all companies to understand what risks are associated in the processes and accept that the risk does exist.

► In order to minimize the risks, Jim highlighted a few areas on which to focus: having a predictable feedstock, manageable capital expenditures, having an experienced company to help with production, and using reliable equipment in the process.

Many biofuel companies are trying to enter industry in a scaled-down manner. Refineries can cost billions to construct so many firms are putting large refineries in their long-term plans. In order to execute these plans in the future, it is important to have scale-up models.

Having these models will also help in convincing potential investors of the long-term viability of your operation. Jim also advised that firms should anticipate cost overruns, integrate existing technology components into their processes, and to make their processes as "boring" as possible to avoid any surprises. Finally, Jim added that it is important to incorporate a company that is currently engaged in a similar process into your operation. Doing so will allow you to focus on the technology and to allow an experienced company to help you with production.

BIOFUELS COMMERCIALIZATION RISKS: MYTHS, TRUTHS AND SOLUTIONS

Corey Steffek was the final presenter and he spoke about how the investment side looks at different processes. He identified two major hurdles for biofuel companies, scaling the first system and showing that it works and then making that process robust, that is being able to show that you can do it thousands of times and get the same result.

To illustrate the problems that could arise from a fermentation process, Corey pointed to three issues he has come across as a firm tries to scale up. In a fermentation process, the bugs may get sick after a certain point. He has also seen margins drop after the process is repeated a certain number of times. Finally, he has also seen the purity of the biofuel decline as the process is repeated. Each of these issues could scare away a potential investor and must be dealt with ahead of time.

For fermentation, it is important to develop a high-end product that is not ethanol. Ideally, a firm would be able to drop a process into an existing ethanol plant. Currently, the technology does not exist for this, but many companies are working towards it. On the thermo chemical side the goal should be to take any feedstock and rearrange it as simply as possible into something that can be used as a biofuel.

Regardless of the process being used, Corey made the point that it is important to have multiple pieces of equipment running at same time so that you can take one down and service it. The technology is not there yet, but people are working towards its development. ##