Bridging from Technology to Commercial Reality in 2009

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Our nation has seen the need for biofuels and has been working in traditional ways to facilitate the creation of a biofuels industry. Accomplishments to date include those shown in Figure 1.

Figure 1 –Major Accomplishments include

- **DOE has issued 5 R&D and 3 pilot/demonstration/commercial funding opportunities**
- **Process and product yields have improved via private and DOE supported research**
- **Favorable language included in recent farm and energy bills**
- **Numerous conferences, committees, organizations and publications have emerged**
- **Technology suppliers and NREL have constructed numerous pilot facilities**
- **Limited quantities of cellulosic biofuels are being produced (see Figure 2)**

Yet after several years we have meager production and the prospects for low production of cellulose based biofuels. We are significantly behind our national goals and even further behind where we could be. Figure 2 lists all of cellulosic biofuel facilities in the US that could be verified. The order is by date first, and then by size until the next year is reached.

Figure 2 –Behind National Goals-estimate of 2010 US cellulosic biofuel production

Company/ Organization	Location city &state	Prod Capacity MGPY	Est. Op. Date	Est. 2010 capacity	Fuel Type
Poet	Scotland, SD	0.02	online	0.02	ethanol
Abengoa	York, NE	0.02	online	0.02	ethanol
Gulf Coast Energy	Livingston, AL	0.02	online	0.02	ethanol
INEOS Bio Inc.	Fayetteville, AR	0.04	online	0.04	ethanol
Verenium	Jennings, LA	0.05	online	0.05	ethanol
Gulf Coast Energy	Livingston, AL	0.20	online	0.20	ethanol
Mascoma	Rome, NY	0.20	online	0.20	ethanol
Verenium	Jennings, LA	1.50	online	1.50	ethanol
Western Biomass	Upton WY	1.50	online	1.50	ethanol
TRI	Durham, NC	0.01	2Q-2009	0.01	diesel
Coskata	Madison, PA	0.04	3Q 2009	0.04	ethanol
Bell Bioenergy	7 locations	0.07	4Q 2009	0.07	diesel
DuPont-Danisco	Vonroe, TN	0.25	4Q 2009	0.25	ethanol
Range Fuels	Soperton, GA	8.0	2Q`2010	4.0	ethanol
Fulcrum Bioenergy	Storey Co., NV	10.25	2011	0	ethanol
ZeaChem	Boardman, OR	1.5	2011	0	ethanol
Clear Fuels Tech	Kauai, HI	1.5	2011	0	ethanol
NewPage	Wis. Rapids, WI	5.9	2011	0	diesel
SE Ren. Fuels	Clewiston, FL	20.0	2011	0	ethanol
Flambeau River	Park Falls, WI	17.0	2012	0	diesel
2010 Total				7.82 transportation	

Figure 2 shows total estimated 2009 estimated capacity for transportation cellulosic biofuels will be about 3.67 MGY. This is overstated. Several of the facilities will not have all of the equipment for the biofuel to meet the required transportation fuel standards. It is likely that this portion will be sold for industrial use. The estimated 2010 production of transportation cellulosic biofuel is in the order of 7.82 MGPY, which is also overstated for the same reasons. This 2010 estimate is less than 0.1% of total transportation fuel used in the US.

MORE IMPORTANTLY *IT IS* AN ORDER OF MAGNITUDE LOWER THAN THE EPA FORECAST OF 100.74 MGY [(2)]. The validated data in Figure 2 is much more accurate than the current EPA forecast. What are the major reasons?

A small team identified seven major commercial gaps [(3)]. These were peer reviewed by respected business and academic professionals. This list of gaps was sent to the 12 DOE award winners for their comment. Figure 3 shows the net of all this input.

Figure 3 – Seven major commercial gaps [(4)]

Commercial Gaps	Brief Discussion
1. Procuring the volume of biomass at the quality and price needed to satisfy owners and lenders.	This gap seems to be the easiest to close for woody biomass. This could become an issue, especially if RPS is adopted.
2. The selling price of the products. Partners and lenders will not typically rely on commodity pricing. Further not all biofuels in the 2007 EISA have been certified by EPA as transportation fuels.	Biofuel incentives are not bankable because they are renewed for 3 year periods and do not reduce market risk. A coordinated approach between DOE and EPA is needed. For example, butanol has superior qualities but is not certified by EPA even for niche fuel markets.
3. Pilot trials are required by DOE, lenders and investors. Typically they are not eligible for funding in a DOE grant for production facilities.	Long pilot trials of months are necessary. They are costly and add a financial hurdle, typically in the millions.
4. Establishing a guarantee for schedule, cost and performance. The processes are not fully commercial and the suppliers are currently not financially strong.	Satisfying the partners and lenders can be done with other financial instruments which add significantly to high capital cost.
5. Obtaining Financing. This was difficult before the financial meltdown. Smaller projects can be self-financed if the owner has adequate financial reserves	Most owners are seeking DOE or USDA loan guarantees. The USDA approved an $80 million loan guarantee for Range Fuels.
6. National Environmental Policy Act (NEPA) compliance	Takes 6 to 18 months, is costly and much work is duplicated for a permit. NEPA is required by law.
7.The ethanol blend limit of 10%	The blend limit restricts biofuel usage

If our Nation is to achieve its goal for an advanced biofuels industry, it appears that making awards to "buy down" some of the risk and letting the market do the rest <u>is an inadequate strategy</u>. We must examine the entire commercialization pathway [(5)] to see what is needed to successfully complete projects in a free market system. This is a different strategy than has been used recently but these are different times. Cash flow to petroleum exporting countries is crippling the U.S. balance of payments and often funnels billions of dollars into nations and areas of the world that are hostile to our interests.

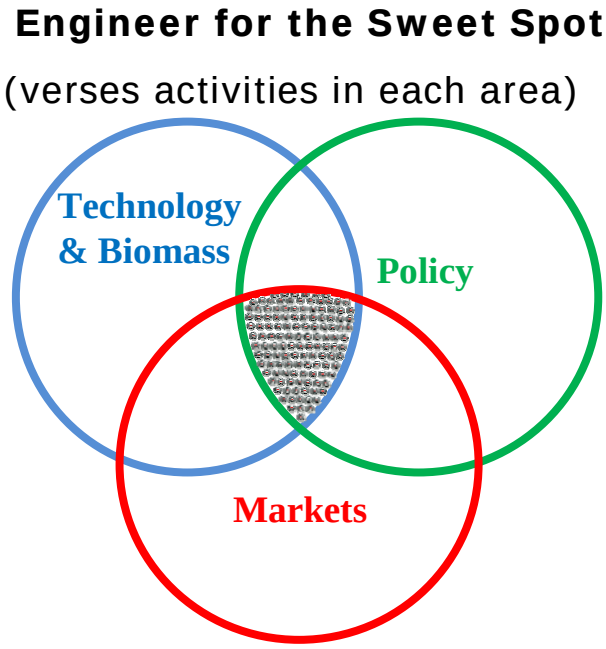
The referenced article identified potential solutions to these 7 gaps to illustrate that legislative action might be required. The solutions were few in number, straightforward and not costly [4].

It is additive to review the business challenges that an individual or company must face in actually building a demonstration or commercial scale facility. Figure 4 shows the major business issues [6].

Figure 4 - Nine Business Issues

1-A business decision that biomass opportunities will be corporately supported and funded
2-Availability of low cost biomass, getting supply contracts
3-Resolution of market issues, getting take contracts
4-Choice of technology
5-Achieving good thermal efficiency with that technology (and with any host facility)
6-Developing a plan to resolve logistics issues
7-Overcomming financial huddles, which includes mitigating the risk of commodity price fluctuations and ESPECIALLY PERFORMANCE GUARANTEES
8-Long pilot run of exact configuration selected
9-Long permitting time

Understand the relationship of raw materials, markets and technology is critical. For any given location the quantity of raw material that exists or can be grown within an economical harvest radius is fixed. This makes raw material an independent variable which must be quantitavely understood. Location can also have a major impact on the type of biofuel that can be effectively marketed. For example, some regions have an excess of gasoline and ethanol while others have shortages or higher logistics costs. Considerations such as these make markets an independent variable which must be quantitavely understood. If it is possible to define the raw material and the market, then conversion technology becomes a dependent variable and should be selected because of its suitability to convert the selected raw material to the biofuel selected for a market.



Those who believe that a superior technology will prevail have difficult business lessons to learn[7].

Those who believe that there is a single mountain or valley of death will begin to feel like the bear that went over the hill only to find another hill.

Those who believe that a DOE grant will solve most problems will find out that typically DOE grant money is not available until items 1 to 8 in Figure 4 have been completed.

The "biofuel bear" must have the resources and stamina to climb the 9 hills in Figure 4 before putting a shovel in the ground. The real issue is that it is cheaper to pump oil out of the ground than to harvest and reform molecules. Technology can lessen this economic gap but cannot close it. The gap might be completely closed when oil demand exceeds supply and prices climb "artificially" high. Then it will be too late to start to create an industry.

If you believe that we need to avoid these crises, then the only immediate solution is additional government support. Yes, some wealthy individuals/venture groups will see future opportunity and invest, but as we have seen in Figure 2, not in the quantity required by our nation. It is believed that some countries will develop proactive policies to facilitate the construction of sufficient facilities to be built so that products, feedstocks, and technologies of choice will emerge. Sufficient capacity could be on line to avoid major crises. The challenge for these countries is to find ways to get support and minimize cost, waste and consequences. Any national intervention must sunset in a way that the economic playing field is again level.

What can we do? Table 5 lists one scenario.

Table 5-One Scenario

1-Contact all of your representatives
2-Insist on accurate forecasts
3-Insist on realistic rulemaking
4-Join organizations that learn and promote facts
5-Join appropriate lobbying efforts
6-Develop your BIOPRODUCTS strategy
7-Now start over with item one.

First, contact all of your representatives and let them know that energy independence is a national security issue. Congress wants energy independence but get conflicting information. When they interact with real businessmen who have facts, they listen and respond. This is not fast, consensus takes time.

Second, watch for proposed rulemaking. EPA and others will issue proposed regulations for the National Fuel Standard Program. Get them and make comments on major issues.

Third, insist that congress do what it takes to meet the Renewable Fuel Standards in the 2007 Energy Independence and Security Act. There will be an initial tendency to make optimistic forecasts to protect the status quo. Find reliable forecasts and use them with your representatives.

Fourth, join organizations that promote knowledge gathering. There are too many reputable organizations to list here but for one example see www.biorefinerydc.org . Another is the Agenda 2020 Technology Alliance. See www.afandpa.org .

Fifth, join lobbying efforts for those proposed rules that benefit both society and your organization. You will quickly find that it is effective and credible to advocate and spend money to publicize what is best for society. A corollary is if you are one or one of a few benefactors, be relatively silent and frugal.

Sixth, develop a BIOPRODUCTS STRATEGY for your facility. One outstanding strategy is only six bullet points long. It is providing one organization a pathway to lower cost and energy independence status with modest, modular projects. More importantly this strategy will be a deterrent to projects which may look good on an isolated basis but which will construct a roadblock to the desired destination.

Seventh, when you have a good bioproducts strategy go back to the first item and start over. You will typically be talking to new representatives but you will be more knowledgeable and effective.

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(2) Page 203(of 549) Environmental Protection Agency 40 CFR Part 80, RIN 2060-A081 Regulation of Fuels and Fuel Additives: Change to Renewable Fuel Standards submitted to Federal register for publication (and comment)

(3)Members of the group were from the Biorefinery Deployment Collaborative.

(4)Thorp, Ben, Johnson, Butch and Akhtar, Masood, "An Open Letter to President Obama", Renewable Energy World, April 30, 2009

(5)Thorp, Ben and Akhtar, Masood, "Innovation without Deployment is a Waste", Paper 360, January 2007

(6)Private conversation with several who responded to federal Funding Opportunities

(7)Thorp, B.A., Key Metric Comparison of 5 Cellulosic Biofuel Pathways, Proceedings of AIChE Annual Meeting, Nashville ,TN, 8-13 November 2009.