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Cutting Through the Coskata Cellulosic Ethanol Hype

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I have a strong distaste for companies or individuals who overpromise and underdeliver. Changing World Technologies (CWT) and their thermal depolymerization (TDP) technology is probably the poster child for companies that promised lots and delivered little. The hype was that they had the "technological savvy" to "turn 600 million tons of turkey guts and other waste into 4 billion barrels of light Texas crude each year." Further, they were going to "make oil for $8 to $12 a barrel." (See TDP: The Next Big Thing).

Of course as time went by, the hype unraveled. But not before the hype resulted in CWT getting earmarks for building their plant (money that went down the drain as documented here) as well as a tax credit inserted by Missouri Congressman Roy Blunt to specifically benefit CWT. That money came out of the pockets of American taxpayers, and could have been better utilized. But it was hijacked by CWT and their overpromises.

These are the sorts of implications that cause me to be very skeptical of companies that make seemingly far-fetched claims. I don't want technologies receiving legal and tax benefits because of hollow boasts. This is also the reason I have been critical in my assessments of some of the cellulosic ethanol claims made by ethanol evangelists like Vinod Khosla.

Earlier this year a company called Coskata caught my attention after GM made a much-publicized investment. Coskata claims that their process "brings the first practical cellulosic opportunity to the market" and that they "will produce ethanol for under US $1.00 a gallon anywhere in the world." That is just the sort of hype we heard from CWT, and therefore was something that I was interested in investigating.

So I took a look at some of their published numbers, compared their costs per barrel of their pilot plant to several other technologies, and wrote a flippant article - Coskata: Dead Man Walking.

The article unleashed an unanticipated firestorm. Journalists started contacting me. The government contacted me. Investors contacted me. And Wes Bolsen, CMO & Vice President of Coskata contacted me. The first three all wanted to know whether Coskata was the real deal, because I seemed to be the first to conclude that the emperor had no clothes. Wes Bolsen contacted me to state emphatically that they were for real. And he reiterated that during a one-hour phone call in which I was able to quiz him about the process.

The experience taught me a few things. First, as I reach a larger audience than I did a couple of years ago, I have to be more careful about what I write and what I say. When someone at the Department of Energy, or some deep-pocketed investor is paying close attention to what I write, I should never be flippant. If I am going to state that a company is over-hyping their technology,

I need to make sure that I have done a very thorough analysis. As I said in a follow-up essay, sometimes the dead man was falsely convicted.

My initial intent was to write just one short essay on Coskata, but there was so much fallout that I ended up spending an entire week following up. In my follow-up essays I did peel several layers of the onion (I got a much more detailed view of what they are doing), but I still don't think they can deliver on their promise of ethanol for less than $1/gallon. Why? In a nutshell, they are using two pieces of technology that are unproven in the service they have proposed. The technology has only been demonstrated at a small lab scale, and even then it was not all coupled together. On that basis they have made their claims of $1/gallon ethanol.

So what is the source of my skepticism around Coskata's claims? Let's look at two areas that I think are potential problem areas. I want to first look at their claims around the energy usage of the process, and then I want to look at the logistics to get a feel for the amount of biomass required to run a 100 million gallon a year plant. I am not going to offer up solutions to potential problems simply because I would require quite a bit more information to do so. But what I can do is flag various areas that a prospective investor/partner should investigate.

Energy Usage

The ethanol they produce is very dilute; only 3.5% or so according to Wes. This should take huge amounts of energy to purify. Coskata claims they have addressed the energy problem by using membrane technology. The claim is that it takes half the energy of distillation. This is somewhat hard to believe, as I would expect ethanol plants across the country to rush to adopt the technology. I am also unaware of any membrane separation technology that does a good job of concentrating up such dilute solutions of ethanol. The ones I know about may concentrate from 70% up to 90%. If you are starting at 3.5%, you are way outside of what these systems are normally designe for. And the technology isn't brand new. Here is a 2001 article talking up the benefits: Pervaporation comes to age.

Yet there have been numerous ethanol plants built since 2001. Why aren't they being built with membrane separation technology? Without going in and checking their claims, I can't say for a fact whether that claim of lower energy usage is valid. But there are question marks all around it. (Note: I don't dispute the technology, because I know that it works. But TDP also worked; just not as well as advertized. I would just make sure - if I were about to invest in Coskata - that I had a very close look at their claims around this area.)

Coskata also claims that they get "*up to 7.7 times more energy than what is used in making the ethanol.*" In my conversation with Wes, I had asked if this was from Michael Wang. He said yes, which then put that claim into context for me. Michael Wang has created a model (the GREET model) that has been widely misused. The number above - 7.7 - will refer not to the energy that is used in the process but rather to the overall fossil energy used. This is the same way Brazilian sugarcane ethanol can claim an 8/1 energy return, despite the energy intensive process step of separating ethanol from water. This is a valid metric as long as the context is clear. But the context isn't usually made clear. (This is the same metric that has caused some to suggest that it is more energy efficient to produce ethanol than to produce gasoline).

Here is an illustration of the potential problems with this metric. Let's take an extreme example, as I think they are useful in illustrating concepts. Let's say that I have one million BTUs of biomass. But let's say I have a conversion process that is terribly inefficient. I use that biomass in an inefficient process to produce a trifling amount of liquid fuel: 100 BTUs. In the process, 999,900 BTUs - 99.99% of what we started with - are lost in the process because they are used

to drive the process.

But let's say I have to input a small amount of fossil fuels; say in the form of electricity to run a pump. If I used 13 BTUs of fossil fuel to produce the 100 BTUs, then the energy return based on Wang's metric is 100/13, or 7.7. So, I could claim to have a high energy return despite the fact that almost all of the available BTUs are wasted. This is the 'opportunity cost' of those BTUs. Had we used the starting biomass to produce electricity, for instance, we would have had far more BTUs at the end of the process.

Now I am not suggesting that Coskata loses most of their BTUs in the process of making their ethanol. But without a real energy accounting - which the 7.7 number is not - it is difficult to determine whether this process makes better use of the available BTUs than a competing process. A proper energy accounting should take into account the overall BTUs consumed in the process, and not just the fossil fuel usage.

Logistics

David Henson, President of Choren USA (another company involved in biomass gasification), once commented to me "You know, most people just don't understand that biomass isn't very energy dense." David was absolutely correct, but what does that mean? The lower the energy density of a substance, the closer it needs to be to the factory. Imagine hauling potatoes from New York to California in order to convert them into ethanol, and you get the picture. You would certainly burn more fuel transporting the potatoes than you could make from processing them into ethanol.

I believe this issue of low biomass density, which I have referred to as the logistics problem of cellulosic ethanol, is a killer for cellulosic ethanol. In fact, I recently calculated that to keep a medium-sized cellulosic ethanol plant running would consume the biomass equivalent of almost 900,000 mature Douglas firs every single year.

However, the Coskata process is not a cellulosic ethanol process. Gasification processes have distinct differences from cellulosic processes (I explained why here). The consequence is that a gasification process can have a higher yield because it converts lignin and hemicellulose in addition to cellulose. In Coskata's case, they promise 100 gallons (+) per ton. How much biomass then to run a 100 million gallon per year facility? A million tons per year. How much biomass is this? If we return to the Douglas fir example, it is the biomass equivalent of around 1.2 million mature Douglas firs **per year**.

That's still hard to wrap my head around, but I can put that in context from my current job. In our wood acetylation plant in the Netherlands, our nameplate capacity is 30,000 cubic meters of wood per year. A cubic meter weighs half a metric ton, so we run 15,000 metric tons per year through our plant (about 17,000 short tons). Coskata proposes to process about 60 times as much biomass through their 100 million gallon per year facility. That is the sort of logistical challenge that boggles my mind, when I try to scale up our process by a factor of 60. Further, that biomass has to be finely processed so it can be pushed through their gasifier (which can be very finicky if the biomass quality varies).

To put in the context of rail cars, the coal cars lined up outside of a coal-fired power plant are a familiar site. According to this, each car carries about 100 tons of coal. For a million tons of coal a year, you would have to have 1 million/(100 tons per car) = 10,000 cars per year coming into and leaving the plant. That's more than a car an hour, 24 hours a day, 365 days a year. And of course coal is quite a bit denser than biomass, so more cars would be required in the case of biomass.

I won't say that's impossible, but it is going to be a significant challenge. All I can say is Coskata better have hired some very good logistical experts. They are going to need them.

The Bottom Line

So what's the bottom line? Let's say you are an investor with a billion dollars burning a hole in your pocket. You need to know if Coskata is for real. Here is my free advice.

The plasma gasification piece and the membrane separation piece both need a very good technical vetting from someone who has signed a secrecy agreement and has access to the experimental data. A technology that works in the lab is one thing. But as you start to scale up, little problems turn into big problems (as was the case with TDP).

You need to know to what extent the gasifier works in conditions close to what Coskata is proposing. These plasma gasifiers are finicky, and normally used for waste disposal. Has the gasifier been tested extensively with a variable substrate like biomass? For how long? What were the results? What were the key challenges? How accurately were the energy inputs measured? In fact, I would probably want to park myself in their labs for a few days, and spend a lot of time talking to technicians. I would want to know - outside of the tours - what's really going on.

Second, I would really focus in on the logistics issue. I would want some serious details on how they are proposing to handle the logistics. How is the biomass going to come into the plant? Has a calculation been done on how far away something can be transported before it becomes break even on the energy? If it is waste biomass already coming into a point source, then it isn't as big an issue. But then I would ask if there is any location in the U.S. that is handling a million tons of waste biomass at a point source (which the gasification plant would be). I would want to see actual examples of someone handling this much biomass.

Finally, I would go over their $400 million capital estimate with a fine-toothed comb. I would ask for an example of any technology that has been piloted in the lab, and then had an accurate capital estimate done at a scale of tens of thousands of times larger than the lab scale. As I have said before, you have different problems at a pilot scale than you had at the lab scale, and the problems become even bigger at commercial scale. The capital estimate is already $400 million for a 100 million gallon per year plant - $61,000 per daily barrel. That puts it at a disadvantage to GTL or corn ethanol. Why wouldn't I expect that capital estimate to climb as they gain piloting experience? Why would I expect them to stick with biomass, when the logistics of gasifying (partially oxidizing) natural gas are trivial when contrasted with biomass logistics?

Conclusion

To conclude, let me state for the record that I *want* Coskata, and for that matter Choren, LS9, Range Fuels, Virent, Nanosolar - to be successful (defined as "produce energy in a sustainable manner"). The world needs solutions to our energy problems, and I applaud these companies for their efforts. I want my kids to grow up in a world with abundant energy. But I never let what I *want* cloud my judgment when I am trying to determine what is true. So, I still believe in scrutinizing their claims very closely, and stating for the record whether I believe their claims to be credible.