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Renewable Fuel Pretenders

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Introduction

This essay initially started out as "*Pretenders, Contenders, and Niches*." However, the section on pretenders grew to the point that I have decided to split that essay up. The first part, *Renewable Fuel Pretenders*, will cover some of the current media and political darlings. The second part, *Renewable Fuel Contenders*, will discuss some options that have received less attention, but in the long term are more likely to have staying power in my view. The final part on niches will discuss situations in which certain options might work in very specific situations.

One thing that probably goes without saying. Most pretenders don't believe they are pretenders. They are often completely sincere people who believe they have cracked the code, and thus they take exception to my characterization. The cellulosic guys, the algae guys, and even the hydrogen guys will insist that I have it all wrong. In fact, following the posting of this essay on my blog, I heard from all of them. I got numerous e-mails assuring me that they really had come up with the solution. What I have discovered in many of these cases is that people often believe this because they have no experience at scaling up technologies. They might have something that works in the lab, but this can instill a false sense of confidence in those who have never scaled a process up.

Reality Begins to Sink In

There was an interesting article in the Wall Street Journal this past week:

U.S. Biofuel Boom Running on Empty

A few pertinent excerpts:

> The biofuels revolution that promised to reduce America's dependence on foreign oil is fizzling out.
>
> Two-thirds of U.S. biodiesel production capacity now sits unused, reports the National Biodiesel Board.
>
> Producers of next-generation biofuels -- those using nonfood renewable materials such as grasses, cornstalks and sugarcane stalks -- are finding it tough to attract investment and ramp up production to an industrial scale.

This all boils down to something I have said on many occasions: **You can't mandate technology.** Just because you mandate that 36 billion gallons of biofuel are to be produced by 2022 doesn't mean that it has a remote chance of happening. This is not a hard concept to understand, but it seems to have eluded our government for many years. Politicians would probably understand that they couldn't create colonies on the moon in 10 years via mandate. They know they can't cure cancer via mandate. But in the area of biofuels, they seem to feel like they can just conjure up vast amounts of hydrogen, cellulosic ethanol, or algal biodiesel.

> Domestically produced biofuels were supposed to be an answer to reducing America's reliance on foreign oil. In 2007, Congress set targets for the U.S. to blend 36 billion gallons of biofuels a year into the U.S. fuel supply in 2022, from 11.1 billion gallons in 2009.
>
> Cellulosic ethanol, derived from the inedible portions of plants, and other advanced fuels were expected to surpass corn ethanol to fill close to half of all biofuel mandates in that time.
>
> But the industry is already falling behind the targets. The mandate to blend next-generation fuels, which kicks in next year, is unlikely to be met because of a lack of enough viable production.

Most people don't realize that the Germans were the first to produce ethanol from cellulose. That happened in 1898. For our political leaders and many industry boosters, cellulosic ethanol is a recent discovery, and thus they expect big leaps in the technology in the next few years. These expectations completely ignore the fact that researchers have been hard at work on making cellulosic ethanol a reality for decades - with little success. The situation is like needing to make a journey of 100 miles, and companies send out press releases every time they move an inch. This gives the false impression that the technology (same story with algae) is expanding by leaps and bounds.

In President Bush's 2006 State of the Union address, he broadly expanded the mandate for ethanol. He voiced his strong support for cellulosic ethanol, and included billions of gallons in the Renewable Fuel Standard - as well as billions of dollars of financial support.

How quickly our politicians seem to have forgotten the 2003 State of the Union, in which Bush set forth his vision of the hydrogen economy:

> "*A simple chemical reaction between hydrogen and oxygen generates energy, which can be used to power a car producing only water, not exhaust fumes. With a new national commitment, our scientists and engineers will overcome obstacles to taking these cars from laboratory to showroom so that the first car driven by a child born today could be powered by hydrogen and pollution-free.*"

We spent some two billion dollars toward that goal. Once again, this ignored many technical and economic realities, and so in May 2009:

Hydrogen Car Goes Down Like the Hindenburg: DoE Kills the Program

> The dream of hydrogen fuel cell cars has just been put back in the garage. U.S. Energy Secretary Steven Chu announced yesterday that his department is cutting all funding for hydrogen car research, saying that it won't be a feasible technology anytime soon. "We asked ourselves, 'Is it likely in the next 10 or 15, 20 years that we will covert to a hydrogen car economy?' The answer, we felt, was 'no,'" Chu said.

My prediction is that in the not too distant future we will start to see headlines like this for cellulosic ethanol. The troublesome barriers to commercialization are quite fundamental, and aren't likely to be resolved by government mandate. If enough money is thrown at it, cellulosic ethanol will certainly be produced. After all, the Germans could do it 110 years ago. But it can never be a scalable, economic reality.

Pretenders

Broadly speaking, in the world of next generation renewable fuels there are contenders, pretenders, and niches. Over the past decade, we have thrown an awful lot of money at pretenders and have little to show for it. There are many reasons for this, but fundamentally I believe it boils down to the fact that our political leaders can't sort the wheat from the chaff. If a proponent extols the benefits of hydrogen, cellulose, or algae - the politicians just don't know enough to ask the right critical questions. They listen - generally to the very people who will benefit from more funding - and then they allocate money. Billions of dollars and little progress later, they or their successors may begin to realize that they have been misled and they start to dial the funding back.

Here is how I define a next generation **Biofuel Pretender**: *A company or group that makes grandiose promises about the ability of a technology to displace large amounts of fossil fuel, despite facing significant (and often unrecognized) barriers to commercialization.*

Here are some examples:

Hydrogen

One of the original renewable energy pretenders. Proponents ignored practical realities in many different areas, including fuel cell vehicles that cost a million dollars, the fact that most hydrogen is produced from natural gas, the fact that the energy density of hydrogen is very low, and the fact that there are multiple issues with hydrogen storage and transport. Technical breakthroughs were being counted on to solve these challenges. After all, we put a man on the moon. Surely we could solve these challenges.

The real problem is that the potential for success falls rapidly as the number of needed breakthroughs pile up. Imagine for instance that each of the following - cost of vehicle production, cost effective storage, and cost effective transport of hydrogen - individually have a 25% chance of achieving commercial viability in the next 20 years. The total chance for success of all three in that case falls to 1.5%. Thus, most technologies that truly require multiple technical breakthroughs will fail to materialize commercially except perhaps over a much longer period of time.

Cellulosic Ethanol

As was the case with hydrogen, this one requires multiple technical breakthroughs before commercial (unsubsidized) viability can be achieved. I won't go through them all now, as I have covered them before. The fundamental reason that cellulosic ethanol won't scale up to displace large amounts of gasoline is that the energy efficiency of the process is so low. You have the sugars that make up cellulose locked up tightly in the biomass - which has a low energy density to start with. So you add energy to unlock the sugar and turn it into ethanol, and then you end up with ethanol in water. More energy inputs are required to get the ethanol out. Even if the energy can be supplied by the by-products of the process like lignin, the net BTUs of liquid fuel that you end up with are going to be low relative to what you started with.

For example, assume you start off with 10 BTUs of biomass. You expend energy to get it to the factory, to process it, and then to get the water out. You burn part of the biomass to fuel the process, and input some fossil fuel. You might net something like 3 BTUs of liquid fuel from the 10 BTUs of biomass you started with. Don't confuse this with fossil fuel energy balance, though. If the external energy inputs in this example only amounted to 1 BTU of fossil fuel, one could claim a fossil fuel energy balance of 3/1. But that doesn't change the fact the final liquid fuel input is a small fraction of the starting BTUs in the biomass.

This is analogous to the situation with oil shale, which is why I have compared the two. There may in fact be a trillion or more barrels of shale oil locked up in Colorado, Utah, and Wyoming. But if the extraction of those barrels requires a trillion barrels worth of energy inputs and lots of water - then that oil shale might as well be on the moon. So, a trillion barrels isn't really a trillion barrels in the case of oil shale, and a billion tons of biomass is much smaller than it seems when talking about cellulosic ethanol.

So despite the claims from the EPA that the *Renewable Fuel Standard program will increase the volume of renewable fuel required to be blended into gasoline from 9 billion gallons in 2008 to 36 billion gallons by 2022* - that is not going to happen unless the government is willing to throw massive amounts of money at an inefficient process.

Algal Biofuel

Like many, I was initially enchanted by the possibility of weaning the world away from fossil fuels by using fuel made from algae. Proponents wrote articles suggesting that we could do just that, provided the necessary investments are made.

Sadly, the story is much more complex than that. The U.S. DOE funded a study for many years into the potential of algae to produce fuel. (For an overview of where things stand from John Benemann, one of the men who co-authored the close-out report of that study, see Algal Biodiesel: Fact or Fiction?) The problem is again one of needing to surmount multiple technical hurdles, and the close-out report discusses that reality. Again, I won't go into those details, as that has been covered before.

While it is a fact that you can produce fuel from algae, the challenges are such that John has written that you can't even buy algal biofuel for $100/gallon. He said that if you want to separate the reality from the hype, just try to secure a contract with someone to supply you with algal fuel.

Note: Following the initial publication of this essay, a person who has been active with algae research for many years wrote to me: *"In spite of all the hype and non-stop press releases, no one to my knowledge is producing algae on a commercial basis for biofuel production."* Again, if someone claims they are, ask where you can buy some of their fuel.

First Generation Biodiesel

This story is primarily about 2nd generation fuels, and as such I won't get into corn ethanol issues. But I will say a bit about biodiesel. As indicated in the Wall Street Journal story, conventional biodiesel producers are in trouble. Briefly, a conventional biodiesel producer is someone who takes vegetable oils or animal fats and generally uses methanol (almost all of which is fossil-fuel derived) and converts that into an oxygenated compound (called a mono-alkyl ester). This compound has been defined as 'biodiesel', and can be used - subject to certain limitations - in a diesel engine.

Again, the problems are fundamental. It takes a lot of effort (energy, cost) to produce most of the oils that are used as raw materials, and then you have to react with methanol - which usually contains a lot of embodied fossil fuel energy. Presently, the first generation biodiesel producers benefit from a high level of protectionism (to the extent of punishing the more efficient 2nd generation producers). But even with the protectionism and the subsidies, producers are still struggling to survive. What really killed them is that they were exporting a large amount of the biodiesel production to Europe. This enabled them to collect double subsidies - U.S. and European - but the Europeans recently put a stop to that, thus putting the industry in financial crisis.

Miscellaneous

There are a number of miscellaneous pretenders that we probably don't need to discuss in depth, such as various free energy schemes or water as a fuel. If you think you might be dealing with a pretender, one caution flag is when their promoters are from backgrounds that have nothing to do with energy. For instance, the person who founded the dot.com that ultimately morphs into an energy company is almost certainly a pretender chasing funds.

Summary

To summarize, the biofuel pretenders fall into several broad categories. The big ones are:

• Hydrogen

• Most would-be cellulosic ethanol producers

• Most would-be algal biofuel producers

• Most first generation biodiesel producers

This isn't to say that none of these will work in any circumstances. I will get into that when I talk about niches. But I will say that I am confident that none of these are scalable solutions to our fossil fuel dependence. Frankly, I wish the algae story was true. I love the idea of getting renewable fuel from brackish waterways. But I try not to let a hope get confused with what I believe is realistic.

The problem is that political leaders have been, or are still convinced that there is great potential for some of these and we waste billions of dollars chasing fantasies. This is a great distraction, causing a loss of precious time and public goodwill as taxpayer money is squandered chasing schemes that ultimately will not pan out.

In the next installment, I will talk about contenders - options that I think can compete with fossil fuels on a level playing field.