



Postscript with Wang and Khosla

Posted by [Robert Rapier](#) on September 3, 2006 - 8:51pm

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I think the thread on efficiency of ethanol versus gasoline left a lot of things hanging, and there have been some communications with Dr. Wang and Mr. Khosla since then. So, I wanted to more or less close the book on this and share those communications. I don't want to spend another 300+ posts arguing about efficiency, but I do want to let the readers know how this all turned out.

Dr. Wang was clearly miffed about my usage of "sleight of hand". While I do not consider usage of this phrase insulting, I felt like the right thing to do was to apologize since Dr. Wang took offense. So, I e-mailed back to Dr. Wang, Tom (who never again responded) and Mr. Khosla:

Dear Tom, Dr. Wang, and Mr. Khosla:

First of all, let me apologize for the offense you took at my usage of "sleight of hand." Never in my life have I considered that phrase insulting, but clearly you were insulted by it. I have used that term on many occasions, and had that term used against me. For me, it just means that things are not as they appear to be. So please do not presume that I was being intentionally insulting, because I was not.

Second, I have been stunned at the response from publishing our exchange. Between my R-Squared blog and The Oil Drum, the exchange received well over 400 responses to date, and I got around 200 e-mails. And while you may consider me combative and stubborn, I am also open-minded and very analytical. I engage in this discourse as much to learn as to convey information, and I was able to understand through those responses just why people are so confused about this issue of gasoline efficiency versus ethanol efficiency.

The reason I am engaged in this debate is that it is very important to me that we pursue the correct energy policy. While I have argued in favor of certain solutions, I have also spent a lot of time debunking certain claims. I don't believe we do ourselves any favors, nor do we help ourselves make educated decisions by allowing myths to persist.

I agree with Mr. Khosla that maybe there are other questions that are better asked. We can debate many different angles over whether or not we should be advocating ethanol from corn. But this particular point of contention is about whether the claim "the efficiency of producing ethanol is better than the efficiency of producing gasoline" is accurate. I have lost count of how many times I have heard some variation of this claim. Tom, in your initial response to me, you included an attachment which made the claim:

"As you can see, the fossil energy input per unit of ethanol is lower--0.74 million Btu fossil energy consumed for each 1 million Btu of ethanol delivered, compared to 1.23

million Btu of fossil energy consumed for each million Btu of gasoline delivered."

That is simply a false claim. Dr. Wang will probably acknowledge that this claim as written is incorrect, and yet it is derived from his work. That is why I say people are being misled as a result of his work. Perhaps it is unintentional, but when people make a claim such as the one above, they have misinterpreted what is being said, and used this misinterpretation to promote the ethanol agenda.

The real critical point when comparing the two processes is to make sure the boundaries are drawn in exactly the same place and definitions are consistent. When this is done it becomes clear why the above claim as written is incorrect. But please don't misinterpret this into thinking that I am trying to completely rebut all ethanol arguments. I am addressing a single issue.

Again, please accept my sincere apologies for offending you. That was not my intent.

Sincerely,

Robert Rapier

Dr. Wang responded:

Dear Mr. Rapier,

Thank you for your email. Apparently, you know that I was pretty upset with your original way of characterizing my work and my character. Working in the scientific area, I am very careful in using language for characterizing others' work and personalities. I expect that others would do the same to me. Simply put, just like you with great intention of pursuing facts, I have been doing the same myself in my professional career. To characterize me of knowingly misleading the public in biofuel debates is simply wrong. I am gratified that you realized that I treat such mischaracterization seriously.

Getting into the technical discussion that you originated, we all agree that energy efficiency is defined as energy output divided by all energy input (including energy in the feedstock itself). That is, we will take into account Btus in gasoline, ethanol, and all process fuels consumed for producing gasoline and diesel in our accounting for energy input. The amount of process fuels is about 0.25 for each Btu of gasoline produced from 1 Btu in crude oil. Meanwhile, for each Btu of ethanol produced from corn, which is from solar energy during corn growth, about 0.75 Btu of energy are consumed. This amount includes fossil energy (namely, petroleum, natural gas, and coal) in fertilizer production, corn farming, ethanol production, among many other activities. With this definition of energy efficiency (as it is accepted by all of us), ethanol has worse energy conversion efficiency ($1/(1+0.75)=58\%$) than gasoline ($1/(1+0.25)=80\%$). Note that in both calculations, the one Btu in ethanol and gasoline is taken into account as energy input, since they are energy eventually from solar energy in the ethanol case and petroleum energy in the gasoline case. Now you can see that such efficiency calculations take all Btus into account (renewable or non-renewable). That is, the efficiency calculations treat all Btus the same. In reality, all Btus are not created equal. I will get back to this point later.

What has been debated about bioethanol is ENERGY BALANCE, not energy efficiency. Energy balance is defined as the energy in the fuel minus FOSSIL energy input to produce the fuel. Why only fossil energy? That is because to many, fossil is non-renewable. As long as we use it, it will be gone, and it takes millions of years to get it back, if ever. But anyway, we can debate whether energy balance is a right matrix to use for energy policy evaluations. I, together with Mr. Khosla and many others, maintain that energy balance is NOT a good matrix for energy policy debates. But energy balance for ethanol has been debated for more than 20 years and it seems that there is still no way near an ending of this debate.

Now if one thinks a little more about energy balance calculations, one realizes that the calculation excludes renewable energy in energy input accounting, which is a small step to the right direction to differentiate different types of Btus. But it adds all three fossil energy types (petroleum, natural gas, and coal) together. The calculation treats all fossil Btus equal, which is still not accurate for energy policy debates. For example, the US has several hundred years of coal supply, while it may have only 10-20 years of oil supply. I do not think that both of us would disagree that the US should value petroleum Btus more than coal Btus. But energy balance calculations do not provide us results to differentiate these two different types of Btus. Mr. Khosla alluded you about the flaws of energy balance calculations in his email.

With the energy balance definition, fossil energy input for one Btu of ethanol produced is still 0.75 Btu. However, fossil energy input for one Btu of gasoline is 0.25 Btu of fossil process fuels consumed PLUS the one Btu in crude oil that is converted into gasoline. Now you may see that the difference between a fossil energy-based fuel (gasoline) and a renewable fuel (ethanol) lies in the Btu embedded in the fuel itself. If it was not this difference between fossil fuels and renewable fuels, we all would conclude without any calculations that renewable fuels could not compete with fossil fuels with respect to energy (that is, all Btus are taken in account with differentiation).

I have made arguments against energy balance comparisons among energy products because they can be less meaningful or misleading. In the past ten years, I have tried to steer the debate on energy products to meaningful issues such as petroleum reductions, fossil energy reductions, greenhouse gas emission reductions, and reductions in criteria pollutant emissions. My point has been that even though corn ethanol has a positive fossil energy balance value, such debates are not that meaningful. I elaborate this step by step in some of my conference presentations. If you read my publications, you would see the consistency in what I think is more important to debate.

I hope this clarifies my positions. By the way, you indicated that you have read some of my publications, I encourage you to take a look at of the report that I coauthored in May 2005 in which I discussed problems of energy accounting and presented well-to-pump energy efficiencies for many transportation fuels including gasoline and corn ethanol. The report is posted at <http://greet.anl.gov>.

Regards,

Michael Wang

I note in his response that he acknowledges that the efficiency of producing gasoline is indeed

higher than for producing ethanol. But he also says the debate is about how much fossil energy is contained in the input. I disagree with this, because the claim I have been rebutting is "it is more energy efficient to produce ethanol than gasoline."

I responded:

Dear Dr. Wang,

Thank you for the cordial response. It seems that we agree on two key issues. First, the claim that ethanol proponents often make - "it is more efficient to produce ethanol than gasoline" - is wrong. Second, the debate is about more than just this one claim. Furthermore, you touched on the very reason this debate means so much to me: Peak Oil.

I believe that oil production will peak in a few short years, and it will have very serious ramifications for society. Without a doubt, we need to seriously research every possible alternative. This is primarily the reason that I spent my graduate studies at Texas A&M University working on cellulosic ethanol.

However, in my view the current national infatuation with ethanol hampers our preparations for a post-petroleum world. I have talked to many people who think that once the oil starts to run out, we will just switch over to ethanol. After all, they will say "E85 can lead us to energy independence." Or they will repeat some other ethanol myth. That kind of thinking, in my opinion, lulls the public into complacency and provides a fig leaf for politicians so they don't have to seriously address the key issue, which I believe is: We are going to have to learn to make do with a much lower per capita energy usage after oil production peaks.

On the one hand, I applaud Mr. Khosla's willingness to invest in cellulosic ethanol, because I think cellulosic ethanol can indeed make an impact, and I think it has great potential. But on the other hand, I am very concerned about the consistent message I hear from the public that there is really nothing to worry about since cellulosic ethanol will save us once oil production peaks. If Mr. Khosla's cellulosic ethanol ventures fail, it will be much more serious than a mere business failure. This has ramifications for the entire country. Failure will mean that we lost precious years in which we could have been making national preparations for Peak Oil. The fact that this threat is not being taken serious enough frightens me, and that is why I take this debate very seriously.

I hope that helps you better understand my position. And yes, incidentally I have read pretty much all of your publications, and I frequently run simulations with the GREET model.

Sincerely,

Robert Rapier

Dr. Wang responded, but in his response he just indicated that he had made a typo in his earlier response, and he thanked me for my e-mail. At this point, I thought the correspondence was finished, but Mr. Khosla weighed in with some final comments:

Robert, you should then stop talking about the irrelevant variable of "production efficiency" or even "energy balance" or "fossil energy balance" and change the debate to (a) petroleum reduction (since we have lots of coal fossil energy to produce corn ethanol and if you care about the environment also talk about (b) GHG reductions per mile driven. It is not what you say but how it is perceived/interpreted by the masses that is critical.

I am optimistic that at some point increasing CAFE will be mandated to reduce energy used in passenger transportation. I am highly supportive of that. I am not trying to convince anybody that we shouldn't worry about reducing our energy use. Though I worry about peak oil, personally I think that the GHG problem is much more urgent. Market prices will address peak oil but if we have sufficient oil there is not market mechanism to reduce GHG emissions.

There are certainly some interesting points made in this correspondence, but I think it does vindicate my initial position. We can find metrics that favor ethanol, but energy efficiency of production is not one of them. What the proponents are saying is that for ethanol, we are going to count the captured solar energy from growing the corn. For oil, we are going to ignore the millions of years of captured solar energy. We are going to ignore that nature has already done the heavy lifting for us, that we are trying to replicate on an annual basis with ethanol. What you have is a metric, but it isn't an efficiency metric.



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