No Bushels About It - Ethanol *IS* More Expensive than Gasoline

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By Neal Dikeman, Chairman, Cleantech.org

Abstract

Despite significant hype in the cleantech investment community to the contrary - when analyzed on a direct cost basis - corn ethanol is a fundamentally higher cost fuel to produce than gasoline, and not by a small margin – but 2-3 times higher.

Using a direct costs analysis based on resource economics using industry averages and data developed by John S Herold and USDA among other sources we analyze the comparative direct breakeven costs of producing gasoline from crude oil and ethanol from corn feedstock. We analyze these using estimates of average costs on an unsubsidized and untaxed basis, and discuss the potential range of variability for marginal production costs.

The conclusion holds even regardless of doing the comparison on a volumetric basis, a btu content basis, including distiller's grain as a cost offset, or including or excluding subsidies. And expanding the discussion to include cellulosic feedstocks, sugar cane feedstocks, and GHG emissions, likely does not change the conclusion in the short term, though the different cost curves of those resources have implications for the long term.

However, given comparative resource advantage and the inelasticities of energy demand, there are strong arguments for both ethanol in general and corn ethanol in particular despite the current cost disadvantages.

Understanding the analysis is critical to developing investment strategies in ethanol.

About the Author

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He is one the best known cleantech writers and analysts including:

- Successfully calling the overpricing of the first ethanol IPOs and successfully predicting the struggles in cellulosic ethanol production well ahead of the market in 2006.
- Drafting some of the most cited critiques of cleantech investing practices including: What you don't know about energy can kill you (Also known as *Welcome to Refining, Freshman*), Oct 2008, Cleantech.com, The trouble with water, Feb 2007, Cleantech.com, Is Al Gore Nuts?, July 2008, CNET

- Breaking the story of the Applied Material and IBM entries into solar, What does IBM know about solar that we don't?, Jul 2007, Cleantech.com, Is Applied Materials Entering the Solar Sector?, Apr 2006
- Writing over two dozen articles on ethanol economics and investing including: ConocoPhillips CTO on the Future of Technology in Energy, Oct 2008, Is Corn Ethanol Lowering Gas Prices at the Pump?, May 2008, Cellulosic Ethanol – Always the Bridesmaid?, Apr 08, Is Ethanol's Carbon Footprint Bad?, Apr 08, Beware the Allure of Ethanol Investing, Jun 2008, Ethanol, NAFTA, Tortillas and Walmart, Jan 2007, Are Ethanol Companies Risky Investments?, Nov 2006, Upsy-Daisy – Is Cellulosic Ethanol Making Progress, Nov 2006, More Capital Markets Stories for Ethanol, May 2006, US Cleantech IPOs – Analysis of VeraSun, Apr 2006
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Besides founding and editing the Cleantech Blog, he has served as publisher the AltEnergy Review, a private publication on the state of the alternative energy markets for a major energy company, and recruited to write for a large number of the dedicated cleantech publications incl. AltEnergyStocks.com, Sustainable Industries Magazine, Inside Greentech/Cleantech.com, CNET/News.com, and has been interviewed by Greentech Media, Cleantech.com, and EnergyTechStocks.com et al.

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He has been an invited speaker at over 20 cleantech conferences including: Greenvest (Chair), Carbon Finance World (Chair), Electric Power, DOE Opportunity Forum, Cleantech Forum, Cleantech Forum Australasia, Entresource, SFPUC Energy Roundtable, Net Impact, Platts Energy Efficiency Conference, GreenNet:09, ALM Energy Tech Investing, Cleantech Innovation and Growth, California Cleantech Open, EBC Angel and Venture Investing, Wall Street Green Trading Summit, Greentech Investor Online, Emerging Energy Technologies Summit, et al

Professionally, he has advised major oil companies and energy generators on cleantech investing, and cofounded multiple cleantech startups. He is the primary inventor and author of two patents pending, and holds a B.A. History and Economics from Texas A&M University.

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Discussion and Analysis

Just because oil prices are high does NOT mean gasoline is expensive to produce (it really is quite cheap), in large part it just means that oil reserve owners are making lots of profits.

Just because the oil industry *sells* gasoline for a higher price than the ethanol industry can *produce* it, does NOT mean ethanol is cheaper to make. And more importantly, just because crude oil *prices* are higher than ethanol production *costs,* only means that oil companies are making lots of money before the crude reaches the refinery – not that ethanol production is cheaper (these analyses are so apples to oranges as to be difficult even to begin to dissect).

A number of well known analysts and investors have come out stating the opposite, but the numbers don't lie. From Is Ethanol Controversial? Should it Be?, by Vinod Khosla - "*Ethanol production costs in the US today are about $1.00 per gallon before any subsidies or taxes, substantially cheaper than the production cost of gasoline, even if oil was to decline to the mid-40's."* First issue, average production costs for corn ethanol are higher than $1.00 even when ignoring btu content, and counting cost offsets from distiller's grains – and corn costs are rising, so we start off using the best case scenario for the ethanol industry.

The ethanol-is-cheaper crowd is effectively comparing the unadjusted *net production cost* of ethanol to the *price* of the crude oil feedstock at a refinery (a mid-40's oil price equates to a $1.00/gallon feedstock price) – at best that apples to oranges analysis, at worst an obfuscation of the real costs.

When you look at the real numbers and compare *actual direct costs* to *actual direct costs* – the answer is very, very different.

Yes, it is correct to say that when crude is at $40-60/barrel, it is economic to produce ethanol (and along with subsidies sell it for a tidy profit), but ethanol is for now, our highest cost fuel.

So let's step back from comparing the price of oil to the cost of ethanol and look at ethanol and gasoline production on an actual direct cost, per gallon basis for each (adjusted for btu content), and see how the answer plays out.

Consider the actual direct costs involved in producing gasoline

To estimate the actual direct cost of the crude oil landed at the refinery (not price, as the oil owner and industry has already make a tremendous amount of profit before a barrel of oil reaches a refinery), we pulled the 3 year average finding & development costs and 3 year production & lifting costs (including transport) from John S Herold, Inc., one of the leading oil industry analysis firms. The combination ranges from $13 - $15/barrel (less than $0.31/gallon) for US major oil companies, albeit with upward trends.

We then estimated the cost of refining crude into gasoline from industry sources at $8-$12/barrel (typical for a high cost California refinery) or $0.19 to $0.28 per gallon. For a total cost structure of $0.50-$0.60 /gallon. [Note: Total California refinery value add, including profit and indirect costs, has been around $0.40-$0.45/gallon in recent years.]

Actual Direct Cost Analysis		Based on: **Direct Cost Structure**
Gasoline	$/Barrel	**$/Gal**
Finding Cost	$ 7.00	$ 0.17
Lifting Cost	$ 6.00	$ 0.14
Refining Costs	$ 12.00	$ 0.29
Total Direct Cost		**$ 0.60**

Refining Direct Costs based on industry expert estimates
Finding & Lifting Costs based on John S Herold 3 year averages US major integrated oil companies

The global average would be significantly less, as many of the national oil companies who hold the lion's share of global oil production have much lower lifting costs and sunk find costs. However, if the cost structure for the last two years, post oil price boom, is used, it would show a significant upward trend, as industry cost structures rose substantially during that period. It is still a matter for debate whether the subsequent collapse in crude oil prices is being followed by similar cost reductions back to the 2003-2005 levels used in this analysis as oil companies reduce overheads and take commodity price rises (ex. steel) and bubble costs out of their supply chain again, or whether the gradual shift towards higher cost resources has already created a permanent increase in industry direct cost structures that should be factored in. It is our belief that even if the latter is true, an appropriate range would be on the order of 50-100% in finding and lifting costs at the outside, and as a result does not change the conclusion of the analysis.

Now consider the actual direct costs corn ethanol

So how much does is it actually cost to produce the corn for a gallon of ethanol? From the USDA, the average cost to produce a bushel of corn is $2.39/gallon. To estimate transportation costs/bushel, we use a transport cost of 1/5 of a cent /bushel/mile and a 50 mile average transport, believed to be industry standard estimates. Then we used an industry standard ethanol production yield of 2.7 gallons/bushel, to get a $0.92 direct production cost /gallon in corn landed at the refinery – excluding, like in the case of the crude oil costs, indirect costs and profit, if any (though it may include an estimated 4% overhead buried in the USDA numbers).

USDA US Average Corn Production Costs 2001 Report (1997-2001)

Total Cost of Production/Gal		
Cost/Acre		
Operating Costs		$ 160.59
Ownership Costs		$ 60.18
Economic Costs		$ 123.13
		$ 343.90
Yield Bu/Ac		144.00
$/Bu		$ 2.39
Avg Transport Costs		$ 0.10
Total		$ 2.49
Conversion Bu/Gal	2.7	
$/Gal		$ 0.92

These aren't aggressive cost numbers, as since 2001 all the farm input costs have skyrocketed, including fuel, fertilizer, and equipment, base inflation, so actual costs for an ethanol plant for the next 5 years may be 20-50% higher based on an even moderate cost escalation.

If you are wondering how farmers make money (average corn prices over that period weren't much higher than $2.40/bushel, the answer is, unlike oil companies, they often don't, most corn producers actually lose money or barely breakeven. As quoted from a USDA report: "In 2001, the operating and ownership costs per bushel for corn ranged from an average of $1.08 for the 25 percent of U.S. producers with the lowest costs to an average of $2.98 for the 25 percent with the highest costs." "In 2001, 59 percent of corn producers earned a positive net return per bushel after covering their operating and ownership costs from the market value of corn." Source: Characteristics and Production Costs of U.S. Corn Farms, 2001

Analyzing actual direct cost for ethanol production we added the $0.92/gallon cost of corn to $0.50 /gallon in other direct costs, including electricity, fuel, depreciation, labor, and materials, based on the USDA 2002 ethanol production survey. The USDA estimates that 2002 cash operating costs /gallon for ethanol plants were around $0.42 /gallon – so after adding back in such additional costs as depreciation, down-time, and yields, a $0.50 average would likely be a conservative estimate. We then calculated an adjustment for the lower btu content of ethanol, and a net for the sale of distiller's grain. We also calculated the same direct cost based on a corn futures price, in order to estimate what the forward 5 years cost of cost might be after recent cost escalations (the USDA 2001 analysis is now nearly 10 year old data). The result was a direct cost range of $1.70 to $2.80/gallon depending on which method you prefer. [Note: in the most favorable case for ethanol - excluding btu content adjustment but including distiller's grain offset and using USDA 1997-2001 corn costs would have been $1.12/gallon]

Actual Direct Cost Analysis	Based on: **Historical Production Cost of Corn**	Based on: **Current Corn Futures**
Ethanol	$/Gal	
Cost of Corn	$ 0.92	
Price of Corn Futures		$ 1.33
Direct Costs ex. Corn Cost	$ 0.50	$ 0.50
Total Cost of Production	$ 1.42	$ 1.83
Adj for BTU Content	**$ 2.17**	**$ 2.80**
Distiller's Grain - adj of BTU	*$ (0.46)*	*$ (0.67)*
Total Direct Cost	**$ 1.70**	**$ 2.12**

Cost of corn production based on USDA 2001 analysis
Current corn futures prices are around $3.60/bushel, or $1.33/gallon
Direct Costs ex. Corn Cost based on USDA 2002 survey + est. of depreciation
BTU content adjustment – 75,670 BTU/gallon of ethanol; 115,400/gallon of gasoline

So anyway you cut it, the actual direct cost of producing corn ethanol at $1.70 to $2.80 /gallon is 2-4x+ more expensive on average than the $0.50-60/gallon actual direct cost of producing gasoline. Comparing best case ethanol to worst case gasoline can of course bring the comparative differentials closer into line, but not even.

Cost Comparison Breakdown

When breaking it out , the corn feedstock for ethanol is also more expensive on an actual direct cost basis than the crude oil for gasoline.

Actual Direct Costs - Feedstock

Cost/Gallon	Adjusted for BTU	Unadjusted
Cost of Corn	$ 1.41	$ 0.92
Net of Distiller's Grain Offset	$ 0.94	$ 0.62
Cost of Crude Oil (ex refining)		$ 0.31

Or put this way, if we grew our own corn for ethanol and drilled for our own oil for gasoline, all on our own average property, the crude for the gasoline would be ½ to 2/3rds cheaper.

Now what about the cost of the refining? Well, corn ethanol loses here, too. Pure play refiner VeraSun, showed in their IPO prospectus cost of goods excluding corn costs of about $0.70 to $0.80/gallon – with about one-third of that related to fuel/electricity costs (taken at IPO to exclude the effects of rising commodity prices in 2007/2008 clouding the ethanol profitability). However, based on our USDA estimates we concluded a $0.50 average would be a conservative estimate. Remember our typical refinery has a cost structure of $0.20-$0.30/gallon, and even including all overhead, profits, and fuel only reaches c. $0.35-0.45/gallon.

And on a fuel content basis (which is what actually counts for drivers), since ethanol has a lower btu content by volume than gasoline, we have to adjust all the per gallon ethanol costs up by about one third (when counting it as an oxygenate, this may not matter, when counting ethanol as a fuel, well, if you have to fill 33% more often, that's material). As an alternative check on the one-third number, the October 2006 Consumer Reports article tested the issue as well in head to head road tests. The standard ethanol-is-cheaper response has been to argue that we can optimize engines to run on ethanol and carve back some of the btu content loss. There is some partial truth to this, but even then the infrastructure change costs are non-trivial, and cannot just be assumed away.

Now what about the argument for selling distiller's grain? The general argument made to show ethanol is cheaper assumes that ethanol refineries sell distiller's grains out the other side (typically ranging, depending on which process, from 30-40% of the price of corn, or c. $0.35/gallon), and therefore the cost of goods per gallon of ethanol is $0.35 lower. The issue here is apples to oranges again. Like ethanol plants, refineries make and sell other high value products too, e.g. jet fuel, coke, steam, CO_2 that we'd have to subtract if we subtracted distiller's grain. That's what the refining business (ethanol or crude) is all about, optimizing efficiencies, costs, yields, and revenue streams off of feedstock. And keep in mind, if distiller's grain was not sold, the local price of corn would likely be higher, as distiller's grain (unlike coke) substitutes in the animal feed market for some portion of the corn feedstock taken off the market by the ethanol production. So yes, it's a real income stream, and we count it, but not as a cost offset in this apples to apples analysis. Bottom line though, it wouldn't make a difference even if we did – but it would make the ethanol industry's story prettier.

So is it correct to say ethanol production costs are cheaper than gasoline production costs? Not exactly. Not even close.

- ***Corn is more expensive to make than oil is to find and extract*** - The per gallon cost of producing corn is higher than the per gallon cost of finding and producing crude oil.
- ***Corn ethanol is more expensive to refine than gasoline*** - The per gallon processing costs of ethanol are higher than per gallon refining costs of gasoline.
- ***Fuel to process corn ethanol costs more than for gasoline*** - The per gallon fuel costs for processing ethanol are higher than per gallon fuel costs for gasoline.
- ***Offset by the fact that the ethanol subsidies per unit exceed the direct cost per unit of producing gasoline from oil and the ethanol supply chain makes substantially lower profits than the refining supply chain.***

Yes, corn ethanol can be made cheaper than the price of gasoline than today, given crude prices above $40/barrel. But is it cheaper? Not on your life. So, while it is correct to say that when crude is at $60/barrel (maybe as low as $30-40?), it is economic to produce corn ethanol (and along with subsidies sell it for a profit), it is definitely not cheaper to produce it, unless apples are just red oranges.

As other analysts have differing opinions on price curves or choose to use different cost and price referents, this methodology, when adjusting for current or alternative commodities prices, should be useful to analyze changes in cost comparison and relative breakevens.

Why then do ethanol proponents say ethanol is cheaper to make than gasoline? Good question.

A Brief Note on the Impact of Subsidies to the Analysis

How does ethanol make up the difference? Partly with c. $0.50+ cents in direct domestic subsidies and tax breaks of one type or another (on top of the agricultural subsidies for corn), partly because it is being sold as an oxygenate (that can command higher prices) to blend into gasoline to replace MTBE, as well as to meet renewable fuels standards and not as a major fuel source yet, and partly because the ethanol industry is just living on lower profits than the oil industry.

Do the often talked about oil subsidies make a difference in this analysis? Of course subsidies help economics, but in this analysis we are looking at actual costs, not prices or after tax income (the oil subsidies are primarily tax breaks of one sort or another).

In addition, the subsidy price of ethanol in the US can be modeled from between $20-50 per barrel, depending on if you count just the distribution /production subsidies or add in import restrictions, impact of environmental regulations, and corn / agricultural subsidies, and other tax benefits (as most analysts do).

A first order magnitude assessment can be made by the simple expedient of taking corn ethanol direct domestic subsidies on a per unit basis ($0.51/gallon) as a bottom end, and adding the roughly that equivalent level of the domestic import tariff to estimate a top end. This is a level supported by most accessible estimates.

On the oil subsidy side, a web search indicates that the estimates of subsidies to the oil industry range quite broadly in size and methodology, but it is generally accepted to be within a bottom range of $5-15 billion dollars per year domestically, and a top range of perhaps $50 to 150 billion dollars per year, though global estimates as high as $300 billion per year can be found. The top range estimates include a very broad definition of subsidy, and are not all applicable. With global oil demand at roughly 80 mm barrels per day, and the US demand at approximately 20 mm barrels per day, we can establish a first order estimate of per unit oil subsidies of $1-2/barrel to perhaps $10/barrel. Adjusting by 1/3rd to put the estimate on a btu basis, brings our first order ethanol subsidy to be on the order of perhaps 5-100x the gasoline / crude oil subsidies, on a per btu, with a range based on more direct subsidies (almost of the ethanol subsidies typically modeled are direct into production, while the higher estimates for the oil subsidies include military costs and developing world/oil producer consumer subsidies which are unlikely to affect production costs).

Given the large per unit differential advantage in direct costs for gasoline shown, and the even larger per unit differential disadvantage in subsidies estimated for gasoline, it was not obvious at this time that a detailed per unit subsidy analysis was needed.

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Adding Ethanol from Sugar Cane to the Discussion

The general analysis has been that ethanol from sugar cane feedstocks in Brazil is produced at approximately 30% lower cost than corn ethanol, given a combination of 1) extremely cheap land and labor and 2) productive agricultural yields of sugar cane in Brazil, 3) coproduction of electricity from bagasse waste, and 4) the inherently more complex production process needed to convert corn to sugar.

However quotas and $0.54 US tariff on most imported ethanol cancels out this advantage in the US market.

A similar analysis to this one can be done to show that while significantly more competitive than corn ethanol, ethanol from sugarcane feedstock sources is likewise as well significantly more costly than gasoline.

Adding Cellulosic Ethanol to the Discussion

One of the classic discussions in ethanol is the potential for production from cellulosic feedstocks to drastically reduce costs and compete with fuel from crude oil, sugar cane ethanol, and corn ethanol.

At this point there are two primary feedstock paths for cellulosic sources, 1) waste biomass and 2) energy crops. The cost pathways for these feedstock classes have the potential to be drastically different.

On the technology side, there are perhaps five to ten different classes of processes at various stages of development. So far no significant volume is being produced from any of these processes, though several should reach small commercial pilot stage and range from only one to two factors to one to two orders of magnitude below commercial scale within the next 2 to 5 years.

The main economic risk issues can be modeled as follows as 1) feedstock quality – availability, production cost, btu content, and processing challenges 2) feedstock transport cost/ability, and 3) process maturity and scale, 3) commodity price spreads.
Relatively speaking waste feedstocks largely are cheaper, have lower btu content/higher variability or are more difficult to process, require shorter transport ranges to be economic and higher parasitic power requirements than energy crops, and may have better potential comparative cost advantages to energy crops, corn or sugar cane at small to medium scale, but that are likely eroded at medium to larger scales. It is, however, highly unlikely to drop significantly below the cost of corn based, let alone sugar cane based ethanol production in the near term, given typical process plant technology development cycles and the current state of technology.

The prediction for cellulosic ethanol development we made in 2006 and 2008 still hold:

1. The corn market will likely be able to handle significantly more corn based ethanol production through substituting corn from the animal feed market than is currently anticipated.
2. Cellulosic ethanol will come on line to replace a lot slower than anticipated - even when the technology arrives.
3. The early cellulosic plants will likely be residual based, perhaps corn stover from fields already producing for corn ethanol - NOT purpose planted fuel crops.
4. Cellulosic technologies that allow fuel switching and co-firing will have an advantage.
5. Because of the transport issues - cellulosic ethanol will be relegated primarily to vertically integrated plants like the biomass power industry for the near future (where the operator owns its own fuel supply). They will struggle to compete on price with corn based ethanol.

And given the process technology maturity, scale, transport, and resource economic issues, both market entry and market share likely will roughly be governed by the ranking on preferred processes (with some allowance for process that involve more than one), and given feedstock, scalability, yield, and transport issues, sugar cane and corn fermentation will remain the market and cost leaders for some time.

1. Fermentation
2. Thermochemical
3. Catalytic
4. Enzymatic
5. Wildcards

Roughly the farther down we go on this ranking the higher the risk of failure, the higher the current cost, the more difficult the scalability (if you swap #1 and #2), the higher the reliance on future technological advances, and the higher the requirements for vertical integration to make the economics work.

Adding GHG Emissions to the Equation

A wide range of analyses have been done attempting to model the GHG emissions footprint of corn based ethanol compared to gasoline. The range of these analyses generally conclude ethanol is between 1/4rd to 1/3rd lower to 1/4rd to 1/3rd higher, depending primarily on 1) transport distances and methods, 2) land use changes and ag production methods, 3) and the GHG footprint of the parasitic power sources. Point number two above tends to be the biggest contributor to the differences in opinion in the research. We have written on this topic before. Given the range of these conclusions, what is the effect of bringing GHG emissions footprint and a price of carbon into our analysis?

The short answer is it depends. It is highly likely that in a carbon constrained world, ethanol at some range of scale is a significant contributor to *reducing* GHG emissions, but at a significant scale of perhaps 10% of fuel volumes or above, it would likely cause a drastic increase given land use changes as the industry moved into more and more marginal land resources. Given that there is also a range in the GHG footprint in gasoline (though not as wide as that of ethanol) based on feedstock source, feedstock quality, refinery operations and efficiency, and end use, and that the more marginal sources of crude oil tend to be the higher GHG footprint, it is not a simple question to understand in a GHG constrained world and at varying prices of carbon what the impacts on comparative cost advantages of various transport fuel feedstocks and technologies will be.

A Brief Note on Economics of Scale

It should be noted that over the range of discussion of both ethanol, sugar cane, and cellulosic sources, true economics of scale are *not* really in play over the ranges important to us. The average 100 to 150 mm gallon per year ethanol refinery, even without the 1/3rd adjustment for btu content, is 1- 2% of the size of the largest crude oil refineries, and at best 5% the size of the typical refinery. One major factor here is the distance limitations and costs on ethanol feedstock transport compared to crude oil, and in that comparison as fairly homogenous and btu rich, reasonably transportable feedstocks with alternative uses supporting a solid supply chain, corn and sugar cane have comparative advantages here to other known ethanol waste feedstocks or energy crops, though are still at a distinct disadvantage to liquid and gas feedstocks, or perhaps even btu rich solid feedstocks like coal or shale.

The main issue here is that it is likely to be much, much more difficult to extract the same level of per unit economics of scale from corn or sugar cane ethanol production than it has been from crude or natural gas, or is from tar sands, or would be from coal to liquids or oil shale production, which are either much more transportable or can be found in much higher and more consistent or much larger concentrations of btu content. Production of ethanol from cellulosic feedstocks is highly likely to fall far short of even corn or sugar can ethanol in its ability to achieve economics of scale for the same reasons.

Trends in Cost Structures

So what gives? Well, the cost structures for both finding crude oil and extracting and refining it are going up as we move into more marginal resources. The debate over Peak Oil is really academic, as the important thing is costs are trending upwards, and we are not likely to see a world in the future where the marginal cost of gasoline from the marginal barrel of oil is less than $10-15/barrel as it has been in the past.

The ceteris paribas cost structures for ethanol at scale from known technologies and widely available feedstocks of corn and sugar cane have been and are expected to continue to fall over some range of scale. Likely not by an order of magnitude in the next two decades, but a one half to one factor reduction levels should be achievable (excluding the price of carbon) based on incremental process efficiencies, continued agricultural yield enhancement, some economics of scale and simply better application of business and process management.

Much of the cost structure reductions in corn have been clouded by simultaneous and in some cases causal, and in some cases temporary, increases in corn ethanol supply chain costs. Rising energy costs from GDP growth for natural gas for energy, oil for transport and ag production costs have proven to be non causal and somewhat temporary or cyclical, if correlated to ethanol pricing. Rising costs for coal fired power, natural gas and oil from uncertainty and future increases in a carbon constrained world may be permanent upwards trends. And rising costs for ag land, ensuring sustainable ag industry profitability (remember historically perhaps 40% of corn farmers lose money), and food impacts are likely negligible over small ranges but permanent and cyclical at scale.

The cost structures for cellulosic resources and processes today frankly range from an order of magnitude higher than current ethanol resources (given the pilot status of the most mature) to completely unknown at scale. Also unknown is the pathway and ability to reach scale, as literally dozens of significantly different approaches are being tried. But costs will likely fall simply by reduction of risk in the transition from small scale pilot to low commercial scale up if nothing else, and likely have the potential within the next two decades to reach the levels of current ethanol production costs and maybe those of gasoline, at least for certain limited resource. However the impact at scale on the cost of any given technology is highly likely to be determined more by feedstock resource economics than by the variance in technology processing costs themselves.

Why Ethanol Anyway

Make no bones about, we have to have cheap transport fuel to run our economy. For hundreds if not thousands of years access to cheap energy resources and the technology to extract them has been critical to maintaining economic growth, social survival, and military prominence, and the US economy has been built since the 1600s on a high cost of labor, extremely low cost of resources, and low and falling transportation costs relative to its trading partners. This unique matrix of comparative advantage arguably was critical in underpinning the development of a technology economy.

The last 40 years, for the first time in American history, our economy began to see decreasing comparative advantage in energy resource production, putting some pressure on our ability to maintain our high labor cost economy, and contributing to the shift from manufacturing and heavy industry based on knowledge and technology to service and knowledge economy selling knowledge and technology. Re-securing that comparative advantage is likely a good strategic objective.

In addition, energy, like food, is one of the most inelastic demand curves known in economics, meaning we need it so badly and can cut back its usage only at such a high cost that small reductions (or increases) in supply mean wide increases (or reductions) in price.

And as expected for inelastic demand curves, the small inflow (a few percentage points) in corn ethanol has been shown to have had a highly outsized effect in reducing price at the pump ($0.30 to $0.40 cents per gallon), for a very small relative subsidy price, and a measurably significant positive impact on trade balances (given that as our energy comparative advantage has shifted, our energy expenditure moves increasingly from a net export to net import balance) – though not as much as might be expected as most of the price differential has been found to have come from refining profits, which is domestic production, not from crude prices.

The GHG emissions debate has shown that ethanol is within striking distance at worst, or measurably superior, at best, to our current best source of fuel.

And why corn? We in the US have a comparative advantage globally in producing the feedstock, the technology is known at reasonable scale, the costs are falling and likely within a 10 year striking distance of expectations of marginal production costs in a rising cost environment for our crude oil resource.

But let’s be honest with ourselves about the economics, risks, opportunities, and reasons for investing in (either through government subsidies or private capital allocation) our energy future.

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Note: The author has no direct investments in or financial incentive related to ethanol or ethanol stocks.