The Real Corn-Ethanol Transportation System

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Summary. The short example presented here builds on the similar calculations described at http://-zfacts.com/p/60.html, see **Table 1** for details. **Figure 1** shows that the energy-equivalent price of ethanol in the US is essentially equal to the unleaded gasoline prices in Europe. But there is a fundamental difference. The gasoline taxes in Europe find their way back to the society and fund energy research, mass transit systems, highway upgrades, etc. Corn *and* ethanol subsidies in the US channel money from the society to big agribusiness.

Since transportation consumes about 2/3 of the 21 million barrels of crude oil we devour every day, doubling the car mileage, using more freight trains, mass transit, and more efficient planes will save at least 7 million barrels of crude oil per day *if* the price of fuel is also doubled through taxation. This solution is perfectly doable in 20 years, without ravaging the US economy and environment with excessive biofuel production and the silly hydrogen car.

Explanation. Suppose that one accepted the unrealistically high ethanol yield[1] used by the USDA and their nonphysical coproduct energy credits[2], and one claimed that the net energy ratio of corn ethanol production were as high[3] as 1.34. Consistently with this claim, for each 1 unit of input fossil energy, one would get 1.34 units of output fossil energy as ethanol, or for 3 units of input energy, one would get 4 units of output energy. This means that one would have to use the amount of fossil energy equivalent to 3 gallons of ethanol to produce one extra gallon of automotive fuel ethanol. Therefore, it would take the energy in $4/(0.95 \times 0.64 + 0.05) = 6.1$ gallons of denatured ethanol to eliminate 1 gallon of gasoline. The current cost of these 6.1 gallons EtOH is $6.1 \times \$4.55 = \$27.64$, but one would save one gallon of premium high-octane gasoline retailing at \$3.17 as of 06/04/06. So the net cost of displacing one gallon of premium gasoline with corn ethanol would be $\$27.64 - \$3.17 = \$24.47$.

In 2005, the U.S. burned ∼140 billion gallons of gasoline. If one wanted to run a "sustainable" corn-ethanol transportation system[4], one would have to produce $6.1 \times 140 = 851$ billion gallons of denatured

[1] This yield of 2.682 gal EtOH/bushel counts 5% of gasoline denaturant, fusel alcohol, and Brazilian imports of ethanol as parts of the true yield of ethanol produced in the U.S.

[2] To separate starch from the remainder of corn kernels (coproducts), one does not have to spend the enormous amount of fossil energy necessary to distil ethanol beer.

[3] Without the coproduct energy credits the USDA net energy ratio hovers at about 1.0.

[4] A system in which corn ethanol would serve as the main fossil energy source to drive corn agriculture and ethanol refineries. Physics makes such a system clearly unfeasible.

ethanol with 5% gasoline by volume, or 808 billion gallons of pure ethanol. The unrealistically[5] low cost of producing this ethanol would be $23.60 trillions, more than the 2005 U.S. GDP of $12.4 trillions.

At 2.48 gallons EtOH/bushel, one would have to produce 327 billion bushels of corn per year (34 times the mean annual U.S. corn production over the last decade) to replace gasoline currently used in the U.S. Let's suppose that this corn were produced every year at the all-time record yield of 180 bushels/acre in Iowa[6]. One would have to grow corn on 1.8 billion acres, year-after-year, for decades. There are about 400 million acres of arable land and pastures in the U.S. Therefore, one would have to use the land area equal to 4.5 times the current agricultural land area just to satisfy the automotive gasoline use in the U.S. There would never be enough water and soil, and other environmental services to support this madness.

Alternatively, one may claim that the U.S. car drivers receive a subsidy of $\$23.60 - 0.140 \times \$3.17/0.83$ trillion for premium gasoline $=$ $23.07 trillion per year from ancient solar energy and the world. This amount of wealth would disappear *every year*, once the latter subsidy stops. Since the continuous disappearance of wealth at this rate is impossible, the U.S. economy will have to shrink dramatically

[5]One would have to spend additional $ trillions to expand industrial farming (35-fold if all corn went to ethanol) and ethanol refining (200-fold), and protect the entire national water and food supplies, public health, and the environment. Water shortage and pollution, and soil destruction would become extreme across the U.S.

[6]Such consistently high yields are absolutely impossible if one cultivated only corn on all arable land, including marginal fields, and expanding agriculture to non-agricultural land. Also the hybrid corn seed production would take an enormous additional land area and fossil energy.

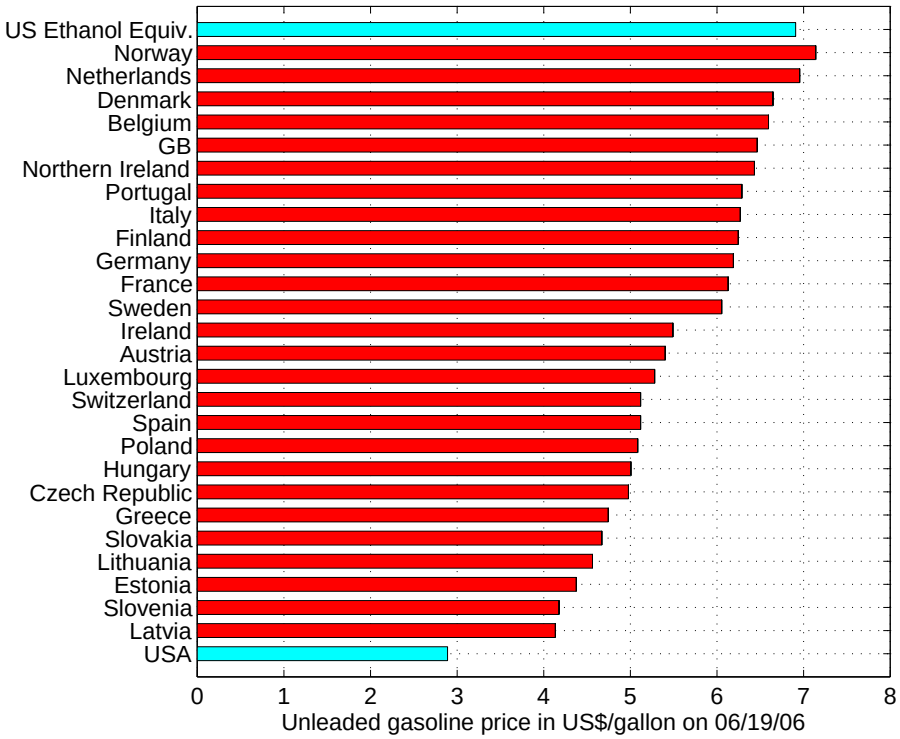

Figure 1: Current prices of unleaded gasoline and the US ethanol on energy-equivalent basis. Note that the production cost of gasoline in Europe and US is virtually the same. The price differential is from taxes that go back to the society in different ways. The perverse nature of ethanol price in the US is that the entire society subsidizes it from taxes, but the profits go to agribusiness. Data sources: http://-www.aaroadwatch.ie/eupetrolprices/ and http://tonto.eia.doe.gov/oog/info/gdu/gasdiesel.asp.

and reconnect with its natural resource foundation. Enter energy efficiency and lifestyle modifications.

I have not discussed here the 45 billion gallons per year of diesel fuel and 25 billion gallons per year of jet fuel used in the U.S., three of which are used by the U.S. Air Force. Oh, and then there are naphtha for heating, and natural gas for heating and cooking...

Table 1: True cost of corn ethanol to taxpayers

Line	Fact	Value	Units
1	2005 EtOH production capacity[a]	4486	10^6 gallons denatured per year
2	"Small producers"[b] EtOH capacity	2597	10^6 gallons denatured per year
3	Mean ethanol tax credit[c] for "small producers"	0.0579	$/gallon denatured
4	VEETC tax credit[d]	0.5100	$/gallon denatured
5	Mean ethanol tax credits	0.5679	$/gallon denatured
6	Cumulative corn subsidies[e] in US from 1995 to 2004	41.90	$ Billion
7	Cumulative corn produced[f] in US from 1995 to 2004	95.309	Billion Bushels
8	Average[g] corn subsidies from 1995 to 2004	0.4396	$/bushel
9	Mean rack price[h] of EtOH (06/19/06)	3.6472	$/gallon denatured
10	Mean EtOH yield[i] from 2000 to 2004	2.4776	gallons EtOH/bushel
11	Mean subsidy[j] of EtOH from corn subsidies	0.1774	$/gallon EtOH
12	Mean state subsidies[k] for EtOH	0.1535	$/gallon EtOH denatured
13	Total mean subsidy[l] of EtOH	0.8988	$/gallon EtOH denatured
14	**Mean cost[m] of EtOH to taxpayer**	**4.5461**	**$/gallon EtOH denatured**
15	Mean premium gasoline price[n]	3.1700	$/gallon
16	**Energy equivalent[o] cost of EtOH to taxpayer**	**6.9089**	**$/gallon GGE**

[a] http://www.ethanolrfa.org/industry/locations/, updated 04/12/06
[b] As in *a*. A small-producers credit of $0.10/gallon for producers of up to 60 million gallons EtOH per year (up from 30 million gallons with the new Energy Bill)
[c] Line $2/1 \times 0.10$
[d] The Federal Volumetric Ethanol Excise Tax Credit, http://www.irs.gov/irb/2005-02_IRB/ar14.html
[e] http://www.ewg.org/farm/region.php?fips=00000, accessed 4/14/06
[f] http://www.ers.usda.gov/Briefing/Corn/, accessed 04/14/06
[g] Line 6/7
[h] http://www.axxispetro.com/ace.shtml, accessed 05/15/06. The mean rack price in the largest ethanol producing states in the Midwest. The rack price of ethanol delivered to both coasts will be at least $0.15 higher because of transportation costs
[i] The mean of (Industry-reported yields - Brazilian imports), multiplied by 0.95 to remove gasoline denaturant, Figure 2
[j] Line 8/10
[k] Figure 3
[l] Lines $5 + 11 + 12$
[m] Lines $9 + 13$
[n] DOE Energy Information Administration
[o] Wholesale cost, excluding environment subsidies. Line $14/(0.95 \times 0.64 + 0.05)$. GGE = Gallon Gasoline Equivalent

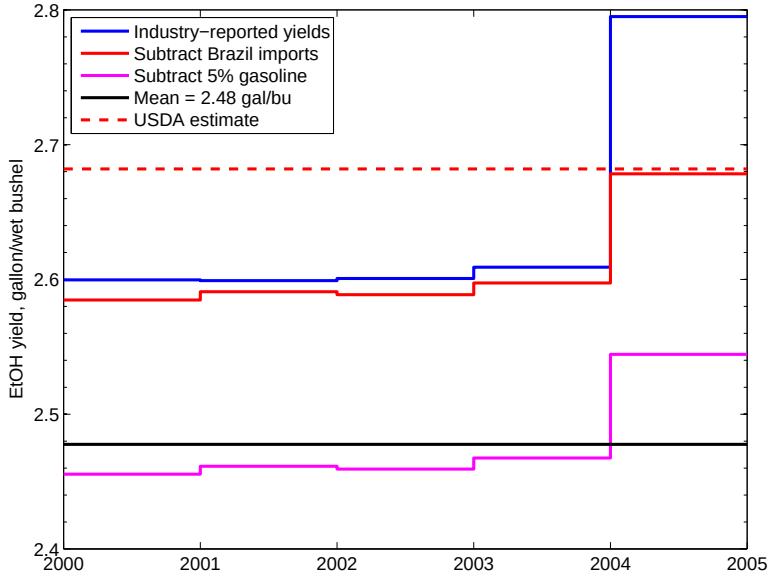

Figure 2: The mean ethanol yield. Source: http://petroleum.berkeley.edu/patzek/BiofuelQA/-Materials/RealFuelCycles-Web.pdf

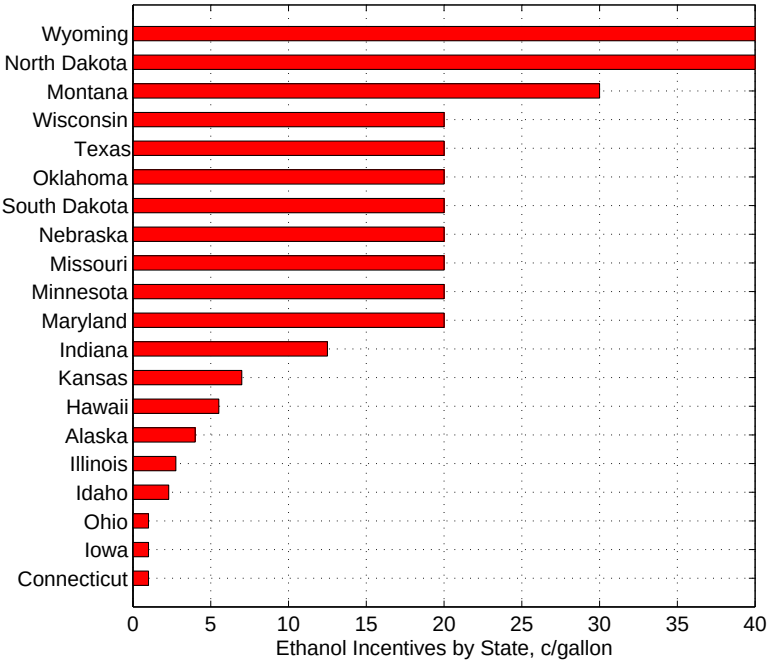

Figure 3: State tax subsidies for ethanol producers. Source: http://www.opisnet.com/headlines.asp, *Sunny Forecast for Summer Ethanol Blending*, accessed February 21, 2005. The mean of state tax credits is \$0.1535/gallon of denatured ethanol.