The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

Rhode Island's Smart Choice

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A recent article in the Providence Journal caught my attention:

Another fuel to power your car arrives in R.I.

Some excerpts from the article:

> May 24--WARWICK -- Hate the gas-guzzling SUV? Worried about greenhouse effects and smog? Fearful that we'll someday run out of oil? Rhode Island's eco-conscious, your day has come.
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> Environmentalists have long offered the benefits of compressed natural gas vehicles as a solution to all of these problems. The engines burn immaculately clean. Vehicles powered by CNG produce only 10 percent of the carbon monoxide and particle discharge of gasoline-powered engines, and half the nitrogen oxides. Carbon dioxide discharge is reduced by 30 to 40 percent.
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> The fuel, which is primarily methane, is cheaper than gasoline -- at T.F. Green, the natural gas will retail for $2.69 for the equivalent of one gallon -- and natural gas-powered cars get better mileage.

The article continued:

> According to the Natural Gas Vehicle Coalition, there were 130,000 natural gas vehicles operating in the United States and 5 million worldwide as of last year.
>
> The states have been the leaders in buying them: In 2005, Governor Carcieri signed an order mandating that 75 percent of all new state vehicles purchased use some sort of alternative fuel -- CNG, hydrogen, ethanol, biodiesel, or others. Rhode Island chose to use CNG.
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> "Initially, Rhode Island invested very heavily into natural gas," said David R. Sheldon, principal engineer with the Department of Administration's Environmental Compliance Unit.
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> While the gasoline-powered Civic GX gets an average highway mileage in the high 20s, the CNG version will average in the mid 30s, officials said.

I have long maintained that converting vehicles to natural gas (NG) makes more sense than converting that NG to diesel via the gas to liquids process (GTL) or ethanol via the corn to liquids process. Note that Brazil, which we immediately associate with ethanol, has over 8 times the CNG fleet of the U.S., despite having a population 100 million less than the U.S.

Consider the options for NG. If we convert it to diesel, we are going to consume about 40% of our initial BTUs in the conversion process, as shown here. But, since the diesel engine is around 35% more efficient than the combustion engine, we have an approximate wash. We will get around the same ultimate fuel efficiency from directly burning the natural gas as we will from processing it into diesel. (But, of course the advantage of GTL is the ability to develop stranded gas reserves).

If we convert it to ethanol, the BTUs in and out are close to a wash. According to the 2002 USDA study Estimating the Net Energy Balance of Corn Ethanol, it takes 77,228 BTUs of fossil fuel inputs – primarily natural gas - to make 83,961 BTUs of ethanol (and a BTU co-product credit of 14,372 BTUs). This is a gain of 8% for fossil fuels in and ethanol out, or a gain of 27% if we include the co-products. But to earn that modest energy gain we mine the topsoil, apply herbicides and pesticides – some of which end up polluting waterways, and we have to build an ethanol refinery.

Also note that the Union of Concerned Scientists report that CNG vehicles “achieve green house gas emission reductions in the range of 5 to 25 percent compared to conventional passenger gasoline vehicles.” The above article from the Providence Journal reported a 30-40% reduction in carbon dioxide emissions. Corn ethanol is reported by Daniel Kammen (the Berkeley ethanol advocate interviewed on the recent 60 Minutes piece on ethanol) to achieve a reduction of 10 or 15 percent over gasoline in terms of greenhouse gas production. So, natural gas is at least as good as ethanol with respect to greenhouse gas emissions, but probably better as a whole for the environment when you consider the environmental aspects of corn farming.

Natural Gas Sources

As I indicated in my essay on XTL, the estimated 3,000 trillion cubic feet of stranded natural gas is enough to produce 300 billion barrels of fuel. However, if we were to burn this gas directly in CNG vehicles, instead of converting it into fuel via the GTL process, we could expect that stranded gas to provide the energy equivalent of over 500 billion barrels of fuel. At current world energy usage rates of 84 million barrels/day of oil, that is enough BTUs to supply us for over 16 years. Consider that if ¼ of the world’s BTUs came from stranded natural gas, the stranded natural gas could contribute to the world energy portfolio for over 60 years at today's consumption rate. Also remember, we are only talking about stranded reserves. There are another 3,200 trillion barrels that are not considered to be stranded.

However, if you are concerned about global warming, as I am, converting all of that natural gas into carbon dioxide may not be too appealing. Fortunately, natural gas can also be renewable if we make if from biomass. Natural gas is created by the anaerobic decomposition of biomass. It can be made from sewage sludge, municipal solid waste, or biomass crops grown specifically for that purpose.

According to the company Gas Separation Technology, between 450 and 650 billion cubic feet per year of methane leeches out of landfills into the atmosphere. This is the energy equivalent of around 75-100 million barrels of oil, floating up into the atmosphere each year. While this is only equivalent to about 1% of U.S. oil demand, according to the EPA methane is 21 times more potent as a greenhouse gas than carbon dioxide. By capturing some of this landfill gas, we can make a small contribution toward our energy requirements while trading methane emissions for carbon dioxide emissions. That's a good potential source of natural gas, and 395 landfill energy projects are already in place, demonstrating the feasibility of the technology.

Of course we are going to need more methane than we can get from landfills. As I mentioned above, we can generate methane from sewage sludge, any waste source of biomass, or from crops grown specifically for methane generation. It is unlikely that we will be able to generate enough methane to maintain our current levels of consumption, but with a major conservation push, methane can be a nice fraction of the energy pie.

EROI

Ah, but what about the EROI? That's an obvious question, and I don't have a good answer. I simply haven't found a good energy analysis. But due to the fact that biogas consists mostly of methane and carbon dioxide, and carbon dioxide has a much higher solubility in water than methane, the separation should not have a high energy requirement. If anyone knows of any literature on this, I would be interested in reading it.

Footnotes

Note that I have used methane and natural gas interchangeably. Natural gas consists primarily of methane (~92-97%), but natural gas from gas wells can contain nitrogen, carbon dioxide, hydrogen sulfide, ethane, propane, and even trace longer chain hydrocarbons.

Finally, I want to note that the article above says that the price of NG right now is $2.69 for a gasoline gallon equivalent (GGE). To put that in perspective, a gallon of ethanol on the CBT today closed at $3.41, and is around $3.70 in California on the spot market. On a GGE basis, this would be $5.00-$5.50 a gallon – twice the price of the NG.