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How Much Natural Gas Do We Have to Replace Gasoline?

Posted by Robert Rapier on July 30, 2009 - 10:06am
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I Took This Picture of a CNG Bus on a Recent Trip to D.C.

You may have seen the recent news that a report by the Potential Gas Committee says natural gas reserves in 2008 rose to 2,074 trillion cubic feet. The New York Times and the Wall Street Journal (via Rigzone) both had stories on it, and T. Boone Pickens issued a press release. In this post, I will look at how long these reserves might last, if used to replace US gasoline usage.

First, from the New York Times:

Estimate Places Natural Gas Reserves 35% Higher

> Thanks to new drilling technologies that are unlocking substantial amounts of natural gas from shale rocks, the nation's estimated gas reserves have surged by 35 percent, according to a study due for release on Thursday.
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> Estimated natural gas reserves rose to 2,074 trillion cubic feet in 2008, from 1,532 trillion cubic feet in 2006, when the last report was issued. This includes the proven reserves compiled by the Energy Department of 237 trillion cubic feet, as well as the sum of the nation's probable, possible and speculative reserves.
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> The new estimates show "an exceptionally strong and optimistic gas supply picture for the nation," according to a summary of the report, which is issued every two years by a group of academics and industry experts that is supported by the Colorado School of Mines.

The Wall Street Journal wrote:

US Has Almost 100-Year Supply of Natural Gas

> The amount of natural gas available for production in the United States has soared 58% in the past four years, driven by a drilling boom and the discovery of huge new gas fields in Texas, Louisiana and Pennsylvania, a new study says.
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> ...the Potential Gas Committee's study was prepared by industry geologists who analyzed individual gas fields using seismic imagery and production data provided by gas producers. The surge in gas resources is the result of a five-year-long drilling boom spurred by high natural-gas prices, easy credit and new technologies that allowed companies to produce gas from a dense kind of rock known as shale. The first big shale formation to be discovered, the Barnett Shale near Fort Worth, Texas, is now the country's top-producing gas field, and companies have made other huge discoveries in Arkansas, Louisiana and Pennsylvania. Together, the shale fields account for roughly a third of U.S. gas resources, according to the Potential Gas Committee.

Pickens had this to say:

T. Boone Pickens Statement on Surge in Estimated Natural Gas Reserves

> Today's report substantiates what I've been saying for years: there's plenty of natural gas in the U.S. I launched the Pickens Plan a year ago to help reduce our dangerous dependence on foreign oil, and using our abundant supply of natural gas as a transition fuel for fleet vehicles and heavy-duty trucks is a key element of that plan. On the same day this report is going out, diesel prices are again on the rise, squeezing the trucking industry. Now more than ever we need to take action to enact energy reform that will immediately reduce oil imports.
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> The 2,074 trillion cubic feet of domestic natural gas reserves cited in the study is the equivalent of nearly 350 billion barrels of oil, about the same as Saudi Arabia's oil reserves.

A number of people have rightly pointed out that a 100-year supply implies usage at current rates. But it got me to thinking about how much natural gas it would take to displace all U.S. gasoline consumption. So in the spirit of my year-ago essay Replacing Gasoline with Solar Power, I will do the same calculation for replacing gasoline with natural gas. The big difference between this calculation and the earlier one is that solar power still has some technical issues to resolve (e.g., storage) and electric vehicles are not yet ready for prime time. On the other hand we are perfectly capable, today, of displacing large numbers of gasoline-fueled vehicles with natural gas.

How Much Do We Need?

The U.S. currently consumes 390 million gallons of gasoline per day. (Source: EIA). A gallon of gasoline contains about 115,000 BTUs. (Source: EPA). The energy content of this much gasoline is equivalent to 45 trillion BTUs per day. The energy content of natural gas is about 1,000 BTUs per standard cubic foot (scf). Therefore, to replace all gasoline consumption would require 45 billion scf per day, or 16.4 trillion scf per year. Current U.S. natural gas consumption is 23 trillion scf per year (Source: EIA). Therefore, replacing all gasoline consumption with natural gas would require a total usage of 39.4 trillion scf per year, an increase in natural gas consumption of 71% over present usage.

Assuming for the sake of argument that the 2,074 trillion standard cubic feet cited in the study is accurate, that the "probable, possible and speculative reserves" eventually equate to actual reserves, and that the gas is economically recoverable, that is enough gas for 53 years of combined current natural gas consumption and gasoline consumption. If you assume that only the proven plus probable reserves are eventually recovered, the amount drops to about 1/3rd of the 2,074 trillion scf estimate, still enough to satisfy current natural gas consumption and replace all gasoline consumption for almost 20 years.

We can also calculate in terms of oil imports. Right now the U.S. imports about 13 million barrels per day of all petroleum products. A barrel of oil contains around 5.8 million BTUs, but oil only makes up 10 million of the 13 million barrel per day figure. Other imports include things like gasoline (4.8 million BTUs/bbl) and ethanol (3.2 million BTUs/bbl). Scanning the list of imports, I probably won't be too far off the mark to presume that the average BTU value of those 13 million bpd of imports is about 5.4 million BTUs/bbl. On an annual basis, this equates to 25.6 trillion scf of natural gas, which would be an increase over current natural gas usage of 111%. Going back to the 2,074 trillion scf from the study, this would be enough to displace imports of all petroleum products (again, at current usage rates and not factoring in declining U.S. oil production) for 43 years.

What's the Cost?

Natural gas is presently trading at about $4 per million (MM) BTU (although December 2009 is trading at almost $6). Oil is presently trading at $71/bbl, which equates to $12.24/MMBTU. Gasoline is presently trading at over $17/MMBTU. Thus, natural gas is a bargain relative to oil or gasoline. Incidentally, I just checked on seasoned wood and wood pellets, and they range from $8-$12/MMBTUs. So it is cheaper to heat your house with gas than with wood. I am not sure I would have guessed that.

While natural gas is a bargain relative to gasoline, converting a gasoline-powered vehicle to natural gas isn't cheap. According to this source, it can cost $12,500 to $22,500 to convert a gasoline-powered car to natural gas. Honda makes a compressed natural gas (CNG) vehicle, but according to this review in Car and Driver the premium over the gasoline version is $8,780. A person would need to drive an awful lot to justify that premium. However, that's what fleets do. They drive a lot. The large price differential explains why fleets would be interested in running their vehicles on natural gas.

Conclusions

So, the good news is that the United States could be energy independent if the newly released natural gas reserve numbers are remotely accurate. It also appears that we have enough natural gas available that civilization isn't going to end any time soon due to lack of energy supplies. There are three caveats. First, energy independence via natural gas could require us to spend significantly more for personal automotive transportation. Second, "possible" reserves may never materialize. Finally, a large chunk of the calculated reserves are based on shale gas, and that requires gas to be in the $6-$8/million BTU range to be economical. Still, it is a bargain compared to gasoline, and it explains why fleets are more receptive to conversion to natural gas than the general public is likely to be for their personal vehicles.

Afterword

After posting this post on my personal blog (R Squared Energy Blog), I received the following e-mail from Marc J. Rauch, Exec. Vice President/Co-Publisher of The Auto Channel, explaining why converting a gasoline powered vehicle is so expensive.

> Hi Robert -
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> Thanks for the work you did on figuring out how much natural gas we actually seem to have (according to current knowledge) and for the related cost comparisons. It's a great and value tool for those of us that believe in CNG (and propane) as a viable engine fuel alternative.
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> One thing that I would like to add (assuming that you didn't already know this or learn it since posting your piece), is that the cost of CNG conversions for existing vehicles is as high as it is because of EPA licensing requirements. For an individual (or shop) to be licensed to do a conversion, the person must pay $10,000 per year, per engine type, per year of manufacture. So that if a conversion shop wanted to do conversions in 2009 for Camrys for the years 1995 to 2005, the shop owner would have to pay the government $100,000 in licensing fees. Then, if he wanted to do conversions on the same models in 2010, he would have to pay the $100,000 again, even though they are the exact same models and engines that he has been licensed on already. And if there is more than one engine involved, i.e., a 6-cylinder and 8-cylinder, the cost would double.
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> Therefore, if a shop owner wanted to do 10 model years of Camrys and Corollas and Celicas, and well as Honda Accords and Civics, unless there were common engines being used in these five models the licensing cost (for just one engine per) would be a half million dollars, which would have to be paid again in 2010. These fees are, needless to say, ridiculous and are only there to ensure that many don't get done (thanks to the gasoline lobby). The cost of the conversion kits are actually relatively inexpensive. If there was a sensible licensing fee (or no fee) the cost for the work could be just a few hundred dollars.
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> To be fair, there is a second part of the cost equation that has to be addressed: trained CNG conversion mechanics. An argument is typically made by those that want to make argument against CNG that there aren't enough trained mechanics. This is somewhat true, but of course there really is no shortage of new and old mechanics that would be willing to learn. So the issue is where can they be trained? The University of West Virginia has a great automotive program that they've "syndicated" to other colleges around the country. In California, two schools (Rio Hondo in So. CA and Yuba College in No. CA) teach the UWV curriculum. They can and do teach CNG conversions.
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> I hope the above wasn't too redundant for you. If you have other information or newer information I would love to hear of it.
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> Regards.

Marc J. Rauch
Exec. Vice President/Co-Publisher
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