The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

What Are Our Alternatives--If Fossil Fuels Are Such a Problem?

Posted by Prof. Goose on April 4, 2007 - 11:45am
Topic: Alternative energy
Tags: batteries, biofuel, brazil, climate change, ethanol, hydrogen, mtbe, natural gas, oil, peak oil, renewables, sugar cane, wind [list all tags]

This is a guest post by Gail the Actuary.

> 1. I love my SUV. Why can't we continue to use oil and gas as in the past?

George W. Bush has given us one reason why we need to make changes - Unstable foreign oil supply. Al Gore has given us another reason - Climate change.

There is a third reason that trumps the first two - WE DON'T REALLY HAVE A CHOICE. Demand for both oil and natural gas continues to rise each year, as the result of China, India and other countries wanting to adopt a lifestyle more like that in the United States. As we saw in Oil Quiz - Test Your Knowledge, world oil supply is likely to decline in the near future. With demand increasing and supply decreasing, there is certain to be a significant gap in the not too distant future.

Natural gas is similar. Like oil, we started with a finite quantity of it, and it is now depleting. The main difference is that we are dealing primarily with a gap between North American supply and demand, rather than world supply and demand, because natural gas is difficult to transport. Demand is rising, because natural gas is viewed as a less-polluting source of energy.

Natural gas supply is likely to decline in the next few years, because most of the larger, more productive sites have already been tapped. New natural gas wells are getting smaller and smaller, so that more and more new wells need to come on line each year, just to stay even. For a while, we were able to make up our shortfall with imports from Canada, but these have begun to decline. In the next few years, both US production and imports from Canada will be declining. It is doubtful that liquified natural gas imports from overseas will be able to fill the gap.

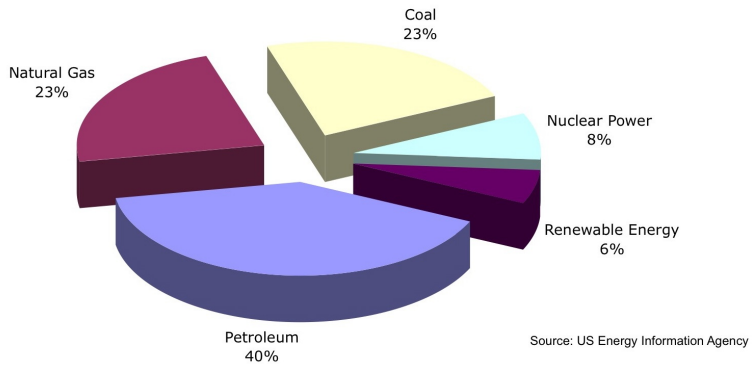
(7 more questions and answers under the fold...along with a study guide! Go Gail Go!)

> 2. How much of the fuel we use is oil? How much is natural gas?

For the United States, 40% of our energy use is petroleum and 23% is natural gas, as shown in

Figure 1. In total, these fuels which are expected to be in short supply comprise 63% of our energy supply.

Figure 1: 86% of US Energy Consumption Is Fossil Fuels



Another 23% is coal, which is the other fossil fuel. Because of its high carbon content, it generates more carbon dioxide than petroleum and natural gas, contributing to global warming. If climate change is a major issue, coal usage should be reduced as well. Together, the three fossil fuels comprise 86% of our fuel supply.

The remaining fuels are nuclear at 8%, and renewables at 6%. The largest renewable is hydro-electric. Other renewables include wood, landfill gas, biofuels, geothermal, wind, solar, and many other new types of energy. Since renewables total only 6%, all are very small in comparison to fossil fuels.

> 3. Won't ethanol cover our fossil fuel shortfall? I know we are growing a lot of corn for ethanol and it is supposed to be a clean fuel.

A few years ago, corn ethanol looked like a very good idea. It would provide an additional market for farmers' corn, thereby helping to hold the price up. Also, as a fuel additive, it would act as a substitute for MTBE (methyl tertiary-butyl ether), which makes gasoline burn cleaner, but does not easily biodegrade, so tends to pollute the groundwater.

While corn ethanol works as a replacement for MTBE, it does very little to increase the liquid fuel supply. It takes a huge amount of corn to produce a small amount of ethanol (20% of the 2006 corn crop added the equivalent of 2.4% to the US gasoline supply energy level.) When the fossil fuels used in growing corn and making ethanol are considered, the net energy gain to the fuel supply in 2006 was virtually nothing (0.4% or even negative, depending on the study).

Ethanol from corn has increased greatly in recent years, because of the significant subsidies it receives. The wisdom of increasing corn ethanol production further is now being questioned because of its poor net energy gain, its indirect impact on food costs, and its adverse environmental impacts (including soil erosion and aquifer depletion, due to its high water usage).

> 4. How about Brazilian ethanol from sugar cane? Will this cover our fossil fuel shortage?

Brazilian sugar cane ethanol is a little better than corn ethanol, but is still unlikely to be more than a small part of the solution to the fossil fuel shortage. It is better than corn ethanol, in that it requires less fossil fuel input, because manual labor is used to harvest the sugar cane and because the unused stalks ("bagasse") are burned to provide the heat for the ethanol processing.

It is likely to be only a partial solution to the fuel shortage for many reasons. The amount of sugar ethanol produced in Brazil currently is similar to the amount of corn ethanol produced in the United States. Even if Brazil doubled its production, and sent the entire increased production to the United States, we would be talking about only a 2% to 3% increase in our gasoline supply.

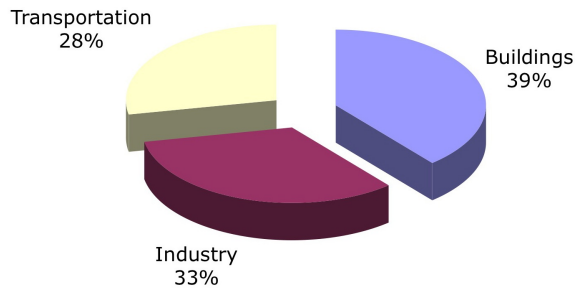
Furthermore, we are again taking about a foreign source of fuel. Climate change issues have been raised regarding the clearing of land for the use in planting more acres of sugar cane. The United States cannot easily follow this sugar cane model, because we do not have much land suitable for growing sugar cane, our growing season is shorter, and our minimum wage would result in much higher labor costs.

5. Could we solve our problem by replacing our SUVs with very energy-efficient models, like Priuses?

This would certainly be a step in the right direction. A couple of things to keep in mind - First, it would be very difficult to do this in practice, except over many years. Once SUVs are viewed as problematic, their resale value will drop greatly, so that they will have little trade in value. Manufacturers will need to produce a huge number of the high milage cars - many more than they would normally sell in a single year. It would take them several years to manufacture the number of cars needed.

Another point to consider is that even if we solve our fuel shortage with respect to transportation, we will still have major shortages in other areas. Figure 2 shows energy use in the United States, divided among buildings, industrial, and transportation. Surprisingly, transportation is the smallest of the three.

Figure 2: Buildings and Industry Consume More Energy than Transportation



Source: US Energy Information

One reason for the high amount of energy used in buildings is that our houses are very large, and we expect them to be heated and cooled to a constant temperature year around. Another area where a large amount of energy is used is in producing our food -- diesel is used for tractors and transportation; natural gas is used to make fertilizer. Manufacturing goods for sale, whether they

are cars or appliances or new houses, takes a large amount of energy as well. We will either need to expand our energy sources to meet the needs of these sectors, or we will need to find ways to use the available energy more efficiently.

> 6. What are our best options for offsetting expected shortfalls in oil and natural gas production?

In Oil Quiz Question 10, we learned that implementing even a known technology on a large scale takes 10 to 20 years. Since implementing a new technology takes even longer, and since declines in oil and gas production are expected in the next few years, our best options for offsetting the shortfall are technologies that already are available. These include:

- Coal - "Coal to liquid" technology for producing liquid fuel has been available since World War II, but technology for sequestering carbon dioxide (necessary to prevent global warming) has not yet been perfected.
- Nuclear - Can be expanded, but waste disposal is an issue.
- Hydroelectric - Most good sites for dams already taken, but a few smaller sites may be available.
- Waste products used as liquid and gas sources, including landfill gas and biofuels from waste products can likely be expanded.
- Geothermal heat pumps. Can only be used in certain locations.
- Wind. Can be expanded.
- Thermal solar energy and photovoltaic solar energy. Can be expanded.
- Biomass such as wood burned for fuel. Difficult to expand significantly.
- Biofuels from food crops, such as ethanol. At best, a very small part of the solution.

Some technologies which may be developed in the next few years include:

- Biofuels from plant material other than foods, including algae.
- Improved batteries, to permit electric cars. May possibly be powered by solar panels on roofs of garages.
- Improved electrical storage, to permit more extensive use of wind energy.
- Electrical power from more distributed sources, to reduce power loss in line transmission.
- Technologies to capture wave energy and tidal energy.

Some of these possible technologies will be discussed more in later posts. It might be noted that hydrogen powered vehicles appear to many years away, so are unlikely to be part of any solution. Hydrogen is very bulky, making fuel storage in a vehicle difficult.

> 7. What is the likelihood that the technologies described in (6) will allow the US energy supply to continue to grow?

Not very high, considering the portion of energy supply that is declining, and the sources available to make up the shortfall. We are expecting a decline in petroleum and natural gas production. These sources together comprise 63% of the US energy supply. This leaves only 37% of energy resources which might be increased (Figure 1).

The largest of the remaining resources is coal, which comprises 23% of the total. While we have all heard stories that the United States has 200 years worth of coal in reserves, some recent analyses suggest that this estimate is very much overstated, and that coal production may also decline in a few years. Even if there is an adequate supply, it is difficult to increase coal production quickly, because of the need to build additional railroad capacity to transport the greater supply. There are also global warming issues with increasing coal production.

Nuclear energy can probably be increased, but lead times for new facilities are very long and there are waste disposal issues.

If we exclude coal and nuclear, we are down to renewables, which comprise only 6% of the energy supply (Figure 1). Starting from such a small base, it is difficult to increase production enough to make up for a shortfall in the oil and gas supply.

8. What can be done, if the various sources for increased energy production do not fully offset the decline in oil and gas production? If this happens, our total energy supply is likely to decline, instead of continuing to increase.

Conservation will likely need to be a part of any future energy plan, to make the best use of the energy that is available. We currently are very wasteful in the way we use energy, so there are likely ways to reduce energy usage, without hardship.

This also will be discussed at greater length in a future post.

To Learn More

Ethanol and Biofuels: Agriculture, Infrastructure, and Market Constraints Related to Expanded Production Report by Congressional Research Service, published March 16, 2007.

Richard Heinberg's Summary of the Coal Situation, published March 22, 2007.

Crude Oil: Uncertainty about Future Oil Supply Makes It Important to Develop a Strategy for Addressing a Peak and Decline in Oil Production GAO Report published February 2007.

Questions for Discussion

1a. In Oil Quiz (Question 7), we said that most geologist predict that oil production will begin to decline between now and 2012, but some predict the decline will begin as late as 2020. We said that governmental agencies, like the US Energy Information Agency, are projecting that oil production growth will continue until at least 2030. Some of the independent oil companies are also projecting long-term growth in production.

Print out pages 13, 47, and 48 of the GAO report listed in the "To Learn More" section. Mark each of the graph items on page 13 as "governmental agency", "oil company", or

"probably geologist", based on the information on pages 47 and 48. Also, print out page 8 of the Hirsch Report, prepared for the Department of Energy in 2005. Based on the projections shown in these reports, would you agree or disagree with our description of the situation?

1b. Is there any reason why an oil company might want to show rising oil production for an extended period? A government agency? If you were preparing the GAO report, would you give equal weight to the predictions of the oil companies, governmental agencies, and independent geologists?

2. The GAO report was issued to the public on March 28, 2007. How much press coverage do you expect it to get? Why?

3. Divide up into two groups. Based on what you have learned in the press and what you have learned here, debate whether corn ethanol production should be expanded.

4. In total, what percentage of the gap between supply and demand for oil and natural gas do you expect to be made up by alternatives of the types listed in Question 6? How much of the gap will be made up by conservation? What will happen if neither of these are very successful?