The Oil Drum: Campfire

Discussions about Energy and Our Future

Thinking about Planning for the Future

Posted by Gail the Actuary on January 24, 2010 - 11:05am in The Oil Drum: Campfire
Topic: Environment/Sustainability
Tags: economic growth, planning [list all tags]

It takes a long time to make big changes to society. I would argue that looking ahead 40 years, to 2050, is probably a wise thing to do for planning purposes.

The problem is that when we look ahead that far, there are so many conflicting ideas of what the future might look like, it is hard do know what to believe. I thought perhaps it might be helpful to put together some graphs of a range of fuel supply possibilities, in order to understand better what the challenges are. Depending on which scenario we believe, perhaps it will give us a better idea of where we should put our efforts.

In this post, I look at the following scenarios:

1. A Business as Usual (BAU) Scenario, as perceived by the press and EIA

2. A Scenario constrained by fossil fuel resource limits only, assuming that there are no issues with Liebig's Law of the Minimum, or reduced demand because of high prices, or international credit issues. It is assumed that wind, solar, and nuclear will continue to grow, at the rates assumed by EIA forecasts. I also show a related scenario with coal phase out.

3. A Crash Scenario, in which some combination of credit collapse, reduced demand because of high prices, and Liebig's Law of the Minimum (relating to oil) cause demand to collapse very quickly.

Obviously, all of these scenarios have wide ranges around them. Some people will believe one is most likely, others will believe another is most likely. But having some idea of what fuel supplies might be 40 years from now gives at least a little context for planning.

BAU Scenario as Perceived by the EIA and the Press

We know what this scenario is supposed to look like, because this is the scenario the US Energy Information Agency has been telling us about. It may not be exactly what climate change leaders are thinking about, but it is likely similar.

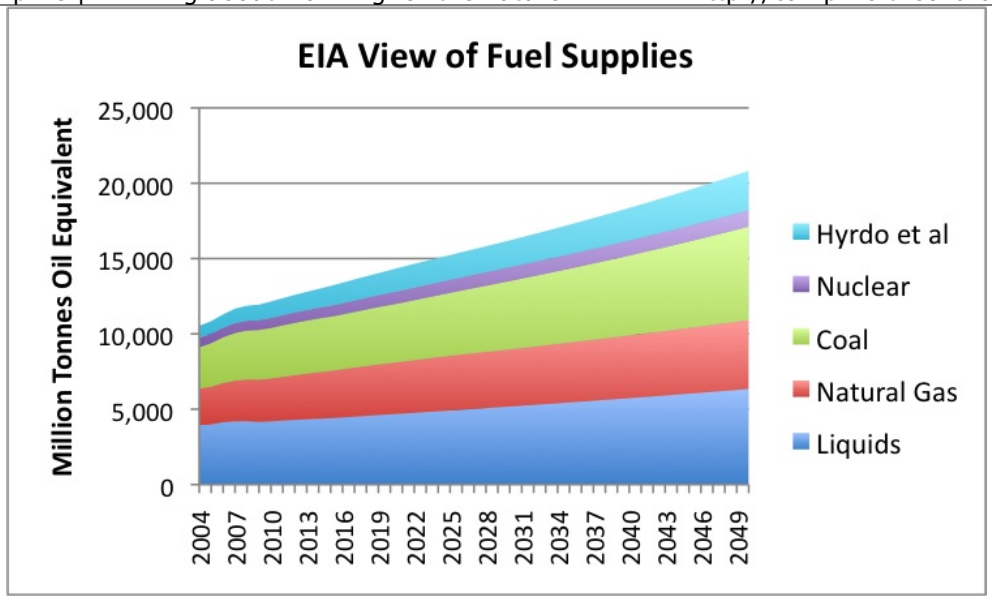

Figure 1. EIA estimates of future fuel supplies. Amounts through 2030 are based on EIA 2009 International Outlook. Annual increases between 2030 and 2050 assumed to be similar to those just before 2030. (Converted to Metric Tonnes of Oil Equivalent)

The EIA forecast is for continued growth in all fuels, but the rate of increase will gradually taper off. Because the growth rate is tapering off, there is a need for additional supply to allow economic growth to continue as in the past. Hence, the emphasis on new fuels from all possible sources, including biofuels, wind, and solar, to be able to continue to meet demand. There is also an interest in energy efficiency.

The EIA doesn't really give the economic growth rate to go with this scenario, but one would presume this would be close to 3% per year for the USA, based on past growth rates. To show how this economic growth would compound over time, I have shown a BAU growth rate, together with some other possible growth rates (for use in discussing other scenarios) in Figure 2 below.

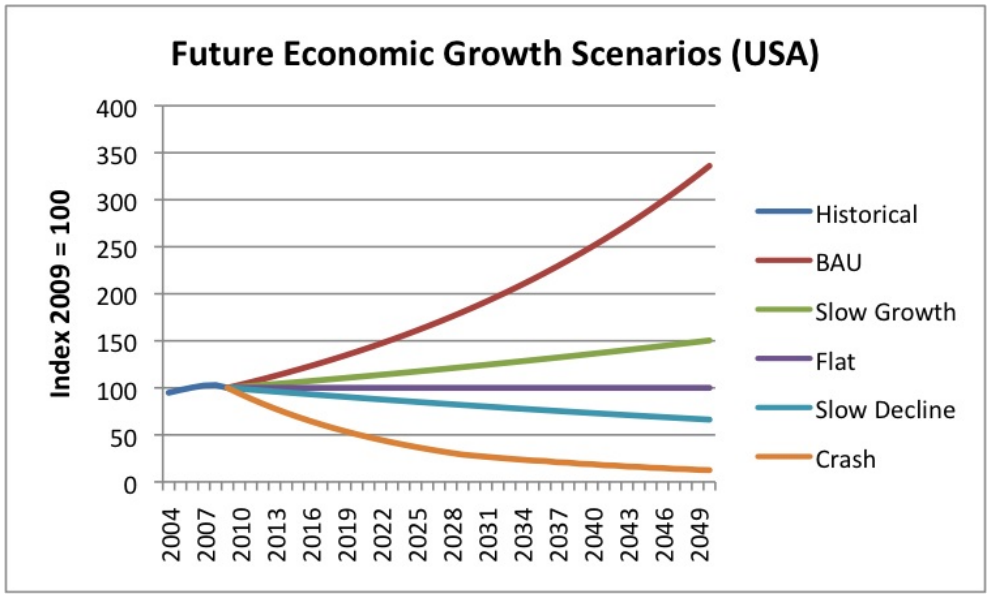

Figure 2. Some theoretically possible economic growth scenarios.

A major reason for showing the BAU scenario is so that a person can see how it compares to the other scenarios.

Scenario Based on Fossil Fuel Decline

What is energy supply likely to look like, considering peak oil and limitations on the availability of natural gas and coal, if there are no economic interferences with supply/demand? I try to show this in Figure 3. There may be at least a small ramp up in coal and natural gas production to offset the oil shortfall, and nuclear and wind and solar might continue to be expanded. I have used the same scale on this graph as on Figure 1, so that a person can compare the two graphs.

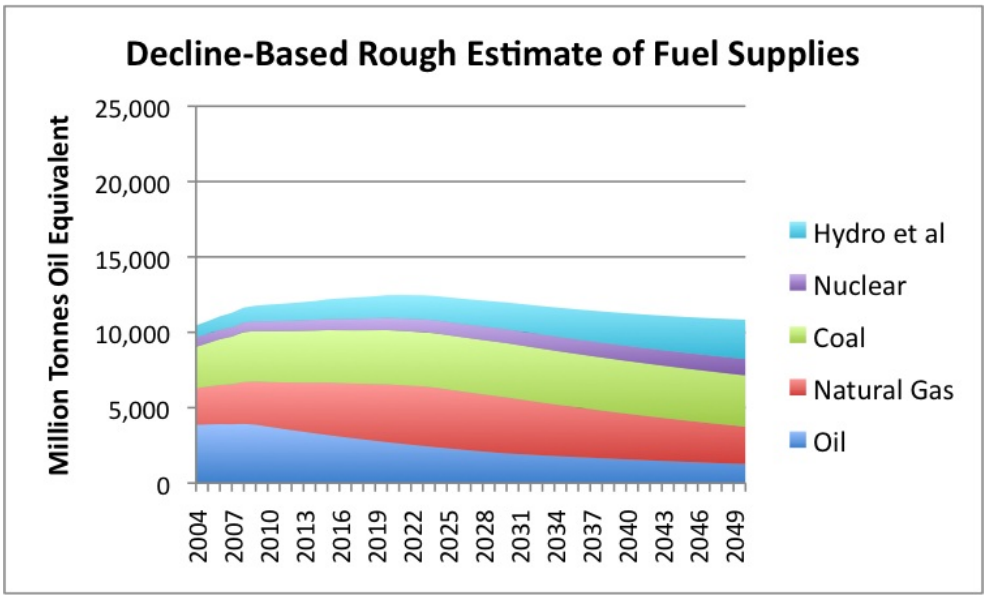

Figure 3.

The coal forecast I used in this scenario is based on Energy Watch Group's 2007 analysis. The oil forecast is based on a combination of the forecast by Energy Watch Group, and Tony Eriksen's Oil Drum forecast. I have assumed world natural gas production will continue to grow until 2023, before tapering off. The hydro et al. estimates (that is, including wind, solar, geothermal, wood etc.) are based on EIA's estimate of expected growth until 2030. The growth rate in the 2029-2030 period is used to extend the forecast to 2050. Nuclear is also based on EIA's estimates used in Figure 1. These assume continued growth in the 1% to 2% a year range.

With this scenario, fuel supply from all sources in 2050 will be roughly 92% of the fuel supply in 2009. This is equivalent to a decline rate of 0.2% a year. One big issue is how many people this smaller energy supply needs to be shared by. According to the EIA, world population is expected to grow by 38% between 2009 and 2050. With this level of population growth, per capita availability of energy is expected to decline to 67% of its current level by 2050.

It is not clear how this level of fuel supply will work out. There is clearly a huge change in mix, with much less oil and relatively more electricity generated. There is a possibility that cities could continue pretty as much as today, and agriculture pretty much as today, if a way could be found to reserve the oil use primarily for food (or if quite a few of farm processes could be electrified). There would need to be fairly sharp changes in other uses of oil, with autos perhaps run by electricity, and other transportation perhaps by electric rail, in order for this scenario to "work".

I am not sure how this would translate to future GDP levels. It is possible that USA real GDP could continue to be flat, or increase a bit, perhaps to 1% a year, because of increases in efficiency, assuming that the oil supply is not significantly bid away by countries with higher population growth. The huge change from an oil to electric economy would be important in making this all work, though.

I have not explicitly included biofuels in this graph but there is enough error range, I don't think this is material. The inclusion of biofuels might make the result a little better--but probably not a whole lot better. It is difficult to see biofuels ramping up much, because of limitations on land availability and water, and difficulty to date in perfecting inexpensive cellulosic ethanol production.

Some would say the scenario shown in Figure 3 is optimistic, because it assumes continued expansion of coal. This scenario also does not address other limits we are reaching (like fresh water), or the likely unwind of debt that is likely to occur with the slowdown in growth. It also doesn't consider the huge cost (or perhaps impossibility) of transitioning away from oil in the transportation sector to other fuel sources--what could in effect be an application of Liebig's Law of the Minimum, because of declining oil supply. If we are missing a necessary element, oil, in some places in the economy, it may cripple that part of the economy, producing a greater decline than Figure 3 would indicate.

An alternate version of this, shown in Figure 4, assumes the same forecasts for all fuels except coal. Instead of following the Energy Watch Group forecast, coal is assumed to be phased out by 2020.

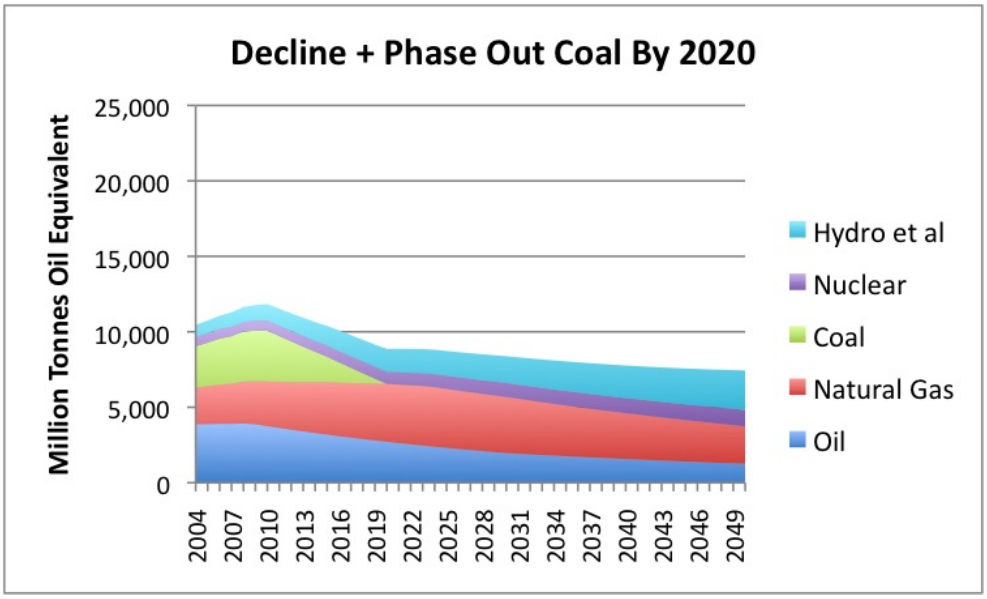

Figure 4.

In this scenario, instead of total world fuels in 2050 being 92% of those in 2009, they would be 64% of those in 2009. The average annual decline in fuel availability would be 1.1%, but this would be especially concentrated in the first few years. Taking into account the forecast growth in population, per-capita fuel availability would decline to 46% of today's level.

The impact would vary considerably by country. The decline would affect coal consuming countries very hard (China, USA, South Africa, for example), and many would likely see major

cutbacks in electricity availability, unless alternate sources could be ramped up quickly. China would likely lose a considerable share of its manufacturing capability, and Australia would lose its very large coal export market, so would likely encounter financial difficulties.

In this scenario, it would be necessary to replace both the loss of oil and coal simultaneously, mostly with natural gas. It is hard to see how this could be done without natural gas supplies running low very quickly, perhaps not long after 2050, with different dates in different parts of the world.

It seems like from a planning point of view, in this scenario one would need to start the transition to living without fossil fuel fairly quickly. Cities would need to be reduced greatly in size, because there would be fewer jobs available in the city, and more manual labor would need for farming. People would need to be resettled on the land, and taught to farm. Plans would need to be made to make essential items, such as clothing, locally. The possible use of horses and other animals for transportation and farm labor would need to be considered.

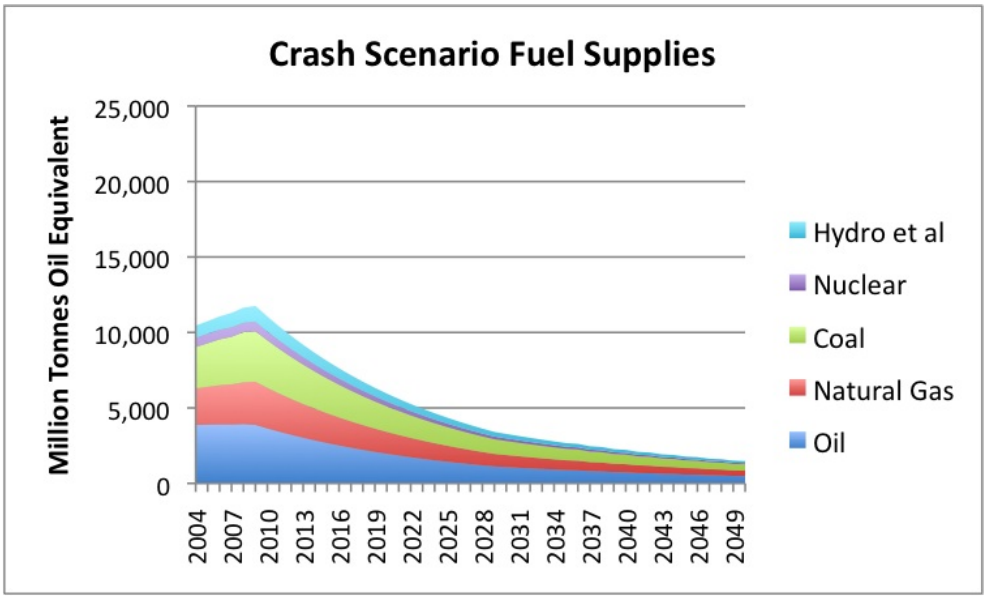

Figure 5.

Figure 5 shows my estimate of what energy usage might look like in a crash scenario. In this scenario, the economy crashes, because of all of the interconnected problems--credit, oil shortages, and international trade problems. There may be other "limits to growth" type issues as well--inadequate fresh water and higher food prices because of food shortages. In this scenario, real GDP drops very quickly (Figure 2).

In this scenario, use of all fuels drops very quickly, (including oil, natural gas, and coal and nuclear) because credit is no longer available, people don't have jobs, and cannot afford the fuel. The anticipated ramp up in wind and solar doesn't really take place, and in fact, repair of transmission lines become more and more difficult, making long-distance transmission of electricity less certain.

While the proportion of coal use doesn't drop (and may even rise), the overall amount consumed drops greatly. In the scenario I show, total energy production drops to 13% of its 2009 level by 2050. One would expect that declines in population would occur as well, at least in some parts of the world.

The issue in the crash scenario is that people will need food and transportation, and their availability is likely to drop off quite quickly. Electrical supply disruptions may become common within only a few years. Local agriculture will be needed very quickly, as will non-fossil fuel transportation. Large cities will likely need to be reduced in size, because food and work for people will not be available.

Obviously, a crash scenario doesn't necessarily have to be as bad as this Figure 5 indicates, but it seems like there is at least some possibility of a scenario such as this, if credit and international trade become major issues, and it becomes difficult to get replacement parts for equipment, including fuel extraction equipment.

So, How Does One Plan?

That is the question for tonight. How does one plan, if there are multiple scenarios possible, some of which are more reasonable than others (and different people have different views regarding which ones are most likely)? Obviously, there are a range of scenarios possible between those shown as well.

Is it possible to do reasonable planning, other than by small groups of people who see the future one way or another, gearing off of their own views of the future?

Over the longer term, it appears that population growth will have far more impact on per capita fuel consumption than wind or solar--partly because wind and solar are so small that even with ramping up, they are likely not to be very large, and partly because in 40 years, there is a lot of room for population growth or contraction. How does one get the population issue addressed, when it is such an unpopular issue (and people are not likely to have very good pensions in the future, so will need children to support themselves)?

With the more adverse scenarios, we need local food production very soon. In other scenarios, local food production isn't an issue at all. If we plan for local food production, but don't need it, we don't lose very much. If we need local food production but don't plan for it, it seems like there is a fairly severe downside. How can we can greater attention be brought to this issue?

I have put together my interpretation of some of the issues of each of the scenarios, but others may have different views. What do you see as the big issues that need to be addressed, that are not being addressed?