The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

How Long Before Uranium Shortages?

Posted by Gail the Actuary on February 19, 2009 - 10:16am
Topic: Alternative energy
Tags: uranium, uranium mining, uranium price [list all tags]

There is a great deal of controversy about how much uranium will be available for future use. I decided to check to see for myself, and came to the conclusion that we are likely headed for problems within the next ten years. Below the fold are a few things I discovered, in looking through reports available on the Internet.

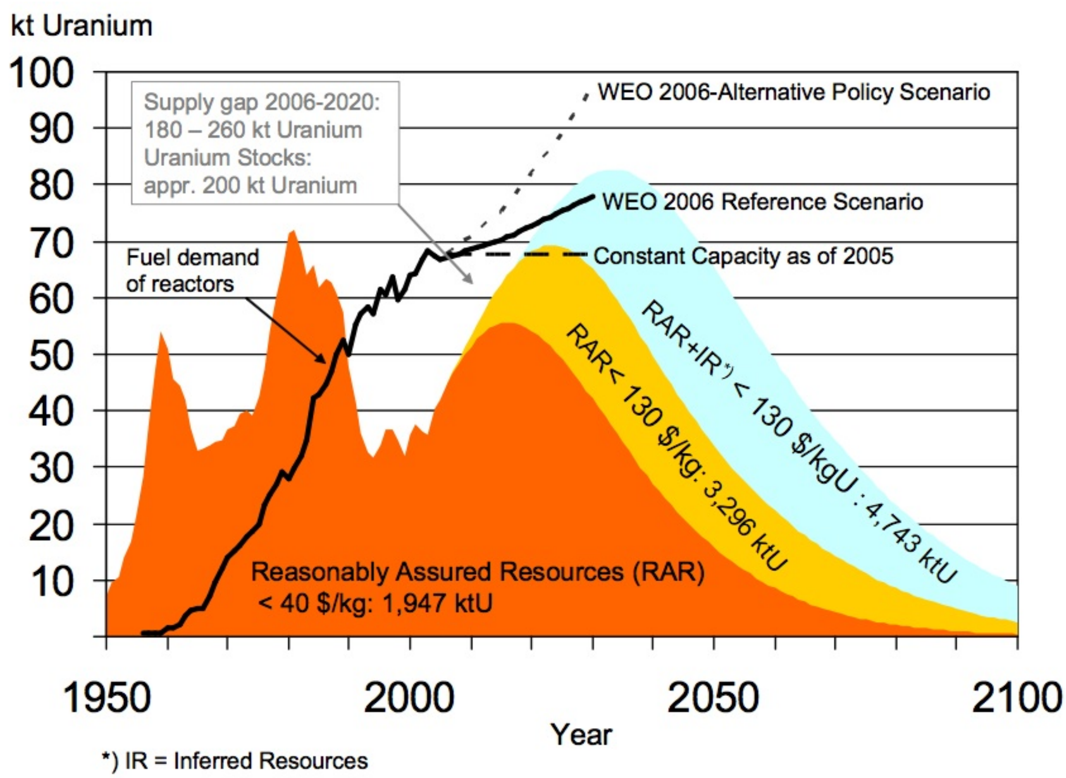

Figure 1. Energy Watch Group: Demand Scenarios together with Forecast of Uranium Production Using Three Different Reserve Estimates (from this 2006 report)

Supply Disagreement

How much uranium is "out there"? One gets a very different answer if one looks at (1) known concentrations that are suitable for ore, versus (2) the amount that is theoretically available, if one considers all of the dilute amounts available in rocks almost everywhere, and in seawater.

Suppose we start from the point of known amounts hopefully suitable for ore. In Figure 1 above, the Energy Watch Group (see this 2006 report) takes three levels of reserves and spreads them out in likely production patterns. The dark orange section represents "reasonably assured resources" that can be economically mined for $40 per kilogram or less. The lighter orange section represents "reasonably assured resources" for $130 per kilogram or less. Current spot prices are about $50 pound, or $110 kilogram, so current prices are now somewhere between these two levels.

The top section in light blue adds "inferred resources". These aren't resources that anyone actually has found and examined. These are resources that one would hope would be somewhere that we haven't looked yet.

Note that in the chart above, there is a likely shortfall even with the light blue "inferred resources" included. The United States has been purchasing recycled Russian bomb material since 1994, and our contract to purchase it continues until 2013. We also have plans to continue buying recycled Russian bomb material after 2013, and to recycle American bombs. These are the kinds of programs which are contemplated in the Energy Watch Group analysis. Even with these in place, their analysis indicates a possible shortfall.

The Energy Watch Group is not the only one who has looked at the question of the adequacy of uranium resources. The International Atomic Energy Agency issued a study in 2001 called Analysis of Uranium Supply to 2050. Its analysis also shows a peak and decline of uranium supply, with a peak occurring in 2024, assuming all resources, including the highest cost resources, can be extracted. If only lower cost resources can be extracted, the peak will be sooner.

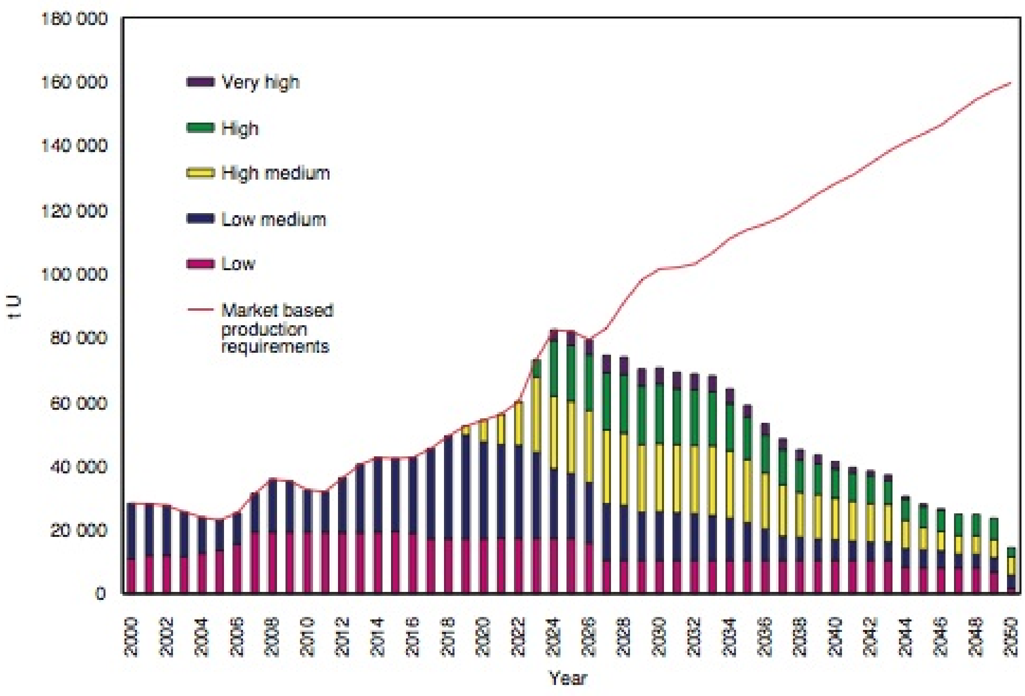

Figure 2. IAEA projection of market-based production from study reasonably assured resources by cost category - middle demand case.

What do other agencies have to say about these projections? The World Nuclear Association issued a report called Supply of Uranium in June 2008 in which it explains how there will be plenty of supply. These are excerpts from the report:

From time to time concerns are raised that the known resources might be insufficient when judged as a multiple of present rate of use. But this is the Limits to Growth fallacy, a major intellectual blunder recycled from the 1970s, which takes no account of the very limited nature of the knowledge we have at any time of what is actually in the Earth's crust. Our knowledge of geology is such that we can be confident that identified resources of metal minerals are a small fraction of what is there.

Uranium supply news is usually framed within a short-term perspective. It concerns who is producing with what resources, who might produce or sell, and how does this balance with demand? However, long-term supply analysis enters the realm of resource economics. This discipline has as a central concern the understanding of not just supply/demand/price dynamics for known resources, but also the mechanisms for replacing resources with new ones presently unknown. Such a focus on sustainability of supply is unique to the long view. Normally-functioning metals markets and technology change provide the drivers to ensure that supply at costs affordable to consumers is continuously replenished, both through the discovery of new resources and the re-definition (in economic terms) of known ones.

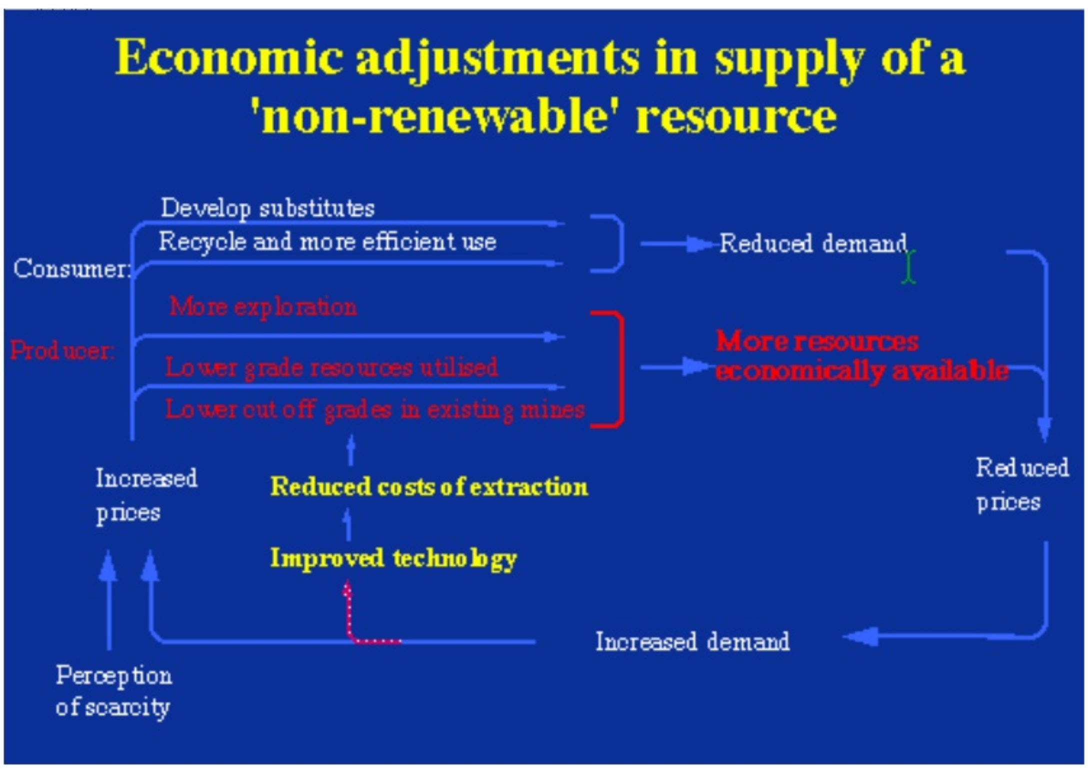

Figure 3. WNA Explanation as to why Supply Concerns are Unwarranted

The World Nuclear Association (with the above faith-based statements) also published a report for £375.00 called The global nuclear fuel market: supply and demand 2007-2030. I do not have a copy of this report, but according to the EIA Energy Outlook 2008, WNA is forecasting that world uranium production will peak in 2015, before slowly declining to 90% of its peak level in 2030. It is strange that the report I quoted above, available on their website, fails to mention this.

In this section, I have not talked about the accuracy of the reserve amounts. In several countries, production has stopped or nearly stopped after available resources have been exhausted. If one compares the reserve figures prior to exhaustion to the amount actually produced, one finds that the stated uranium reserves were significantly higher than the production actually achieved. Below is a chart by Energy Watch Group comparing France's reserves with its actual uranium production. This kind of pattern does not give one much confidence that mining companies will actually be able to convert the reserves (as published by nuclear organizations, which are higher than individual company estimates) into production.

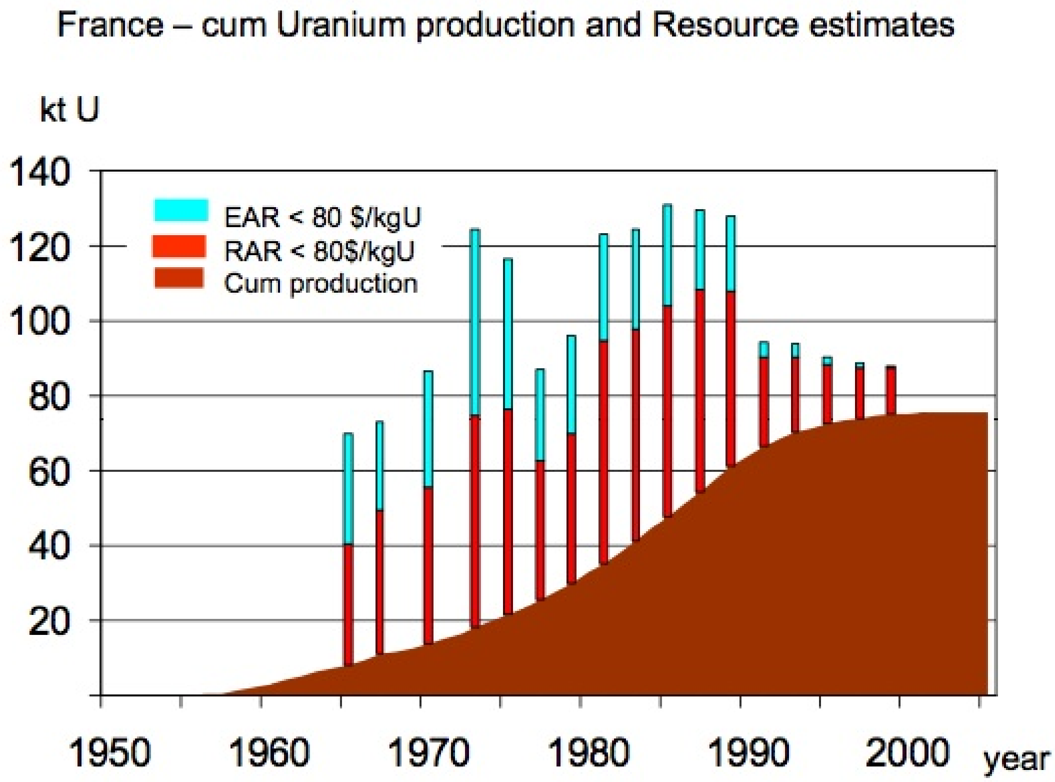

Figure 4. Uranium production for France, compared to prior reserve estimates

Where We Are Now

Energy Watch Group shows this graph of actual production versus demand through 2005:

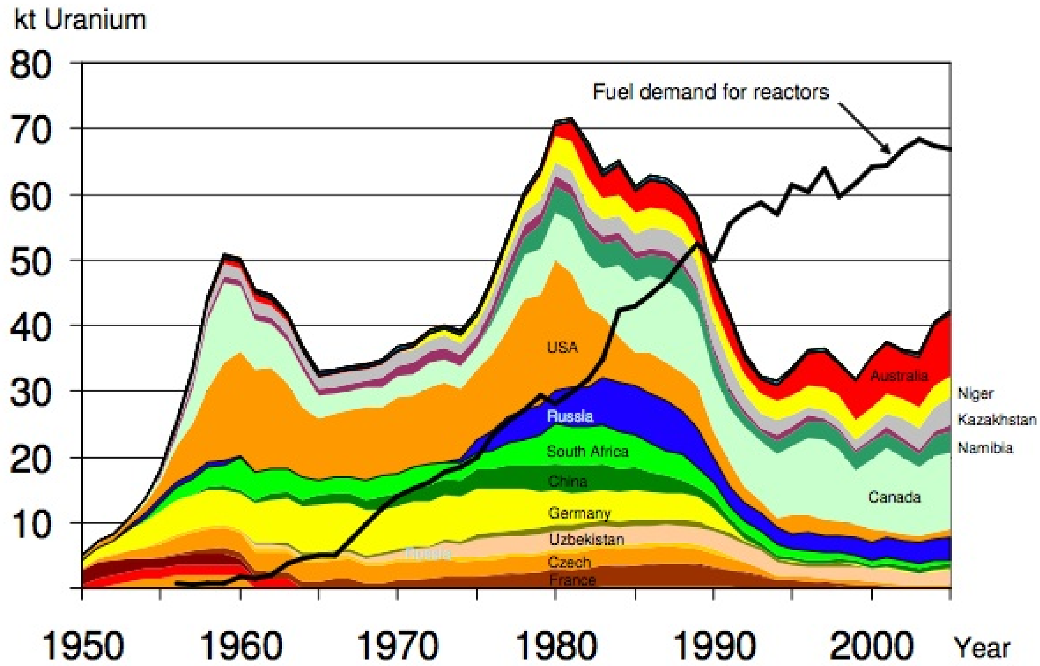

Figure 5. EWG World Production vs Demand

More recent data from the WNA indicates that world production since 2005 has been flat:

Production from mines (tonnes U)

Country	2002	2003	2004	2005	2006	2007
Canada	11604	10457	11597	11628	9862	9476
Australia	6854	7572	8982	9516	7593	8611
Kazakhstan	2800	3300	3719	4357	5279	6637
Russia (est)	2900	3150	3200	3431	3262	3413
Niger	3075	3143	3282	3093	3434	3153
Namibia	2333	2036	3038	3147	3067	2879
Uzbekistan	1860	1598	2016	2300	2260	2320
USA	919	779	878	1039	1672	1654
Ukraine (est)	800	800	800	800	800	846
China (est)	730	750	750	750	750	712
South Africa	824	758	755	674	534	539
Czech Repub.	465	452	412	408	359	306
Brazil	270	310	300	110	190	299
India (est)	230	230	230	230	177	270
Romania (est)	90	90	90	90	90	77
Pakistan (est)	38	45	45	45	45	45
Germany	212	150	150	77	50	38
France	20	0	7	7	5	4
Total world	36 063	35 613	40 251	41 702	39 429	**41 279**
tonnes U_3O_8	42 529	41 998	47 468	49 179	46 499	48 680

WNA Market Report data

Figure 6. WNA [Uranium Production by Country]

Uranium production for the United States continues at a very low level, compared to the amount we use as fuel in nuclear reactors. Recent EIA data shows that 2008 production has declined from the level produced in 2006 and 2007, despite rising numbers of people working in mines and greater expenditure (see this report and this one):

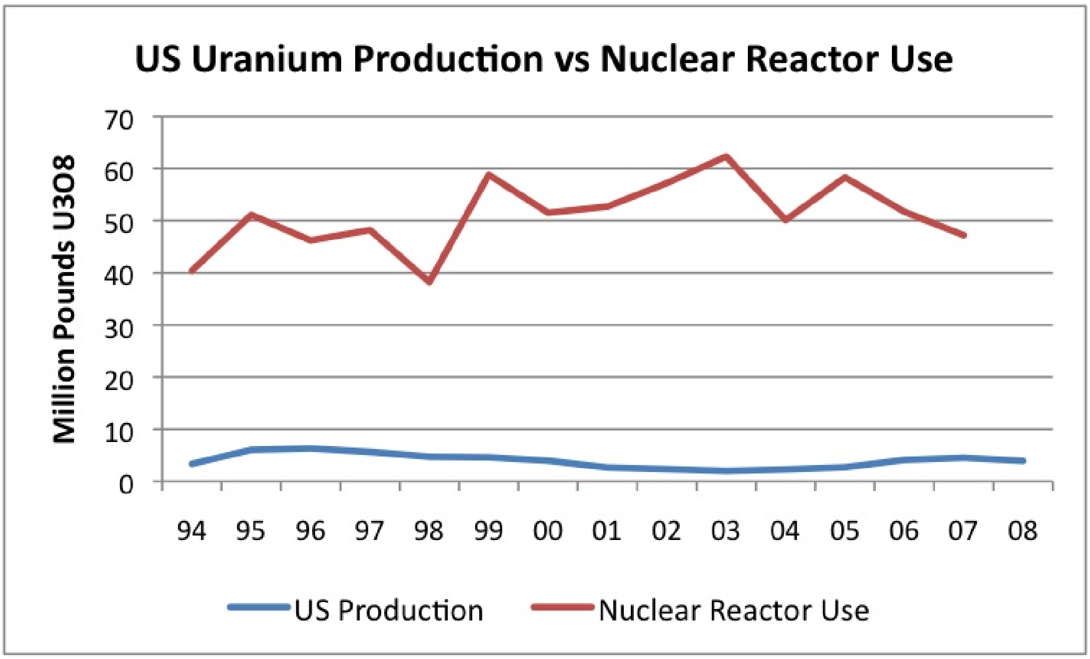

Figure 7. US Uranium Production vs Amounts Loaded into Nuclear Reactors, based on EIA Data

The EIA in International Energy Outlook 2008 says there is no problem: there are lots of reserves (the same ones as in Figure 1, including the light blue). It also says:

> The relatively high price of uranium already is leading to increased output. New mines in Australia, Canada, Kazakhstan, Brazil, and India are expected to add 30,000 metric tons of production capacity by 2010.

Adding new mines takes a long time--one often sees 8 to 10 years quoted as a reasonable time frame. Production in 2007 was only 41,000 metric tons, so increasing production by 30,000 metric tons would represent a 73% increase. This doesn't seem to be happening. If we look at news reports, we find that mining companies are struggling financially, because of high debt loads and low prices available for their products. Production plans are being cut back or delayed.

In Canada, the big new project is Cigar Lake, under development by Cameco. I haven't seen production estimates for the mine, but would guess that they are of the order magnitude of 10,000 metric tons of production per year. Cameco began work on the mine in 2001, but the mine has repeatedly flooded. The mine has very high grade ore (20%), but is located below the water table. The plan is to try to freeze the ground to stabilize the area for mining. The most recent flood was in August 2008. Prior to the latest flood, the planned production date was 2011. No new date has been set. Cameco has not given up yet, but one wonders whether the problems with this mine will ever be worked out.

The other very large project which many had great hopes for was the BHP Billiton's Olympic Dam expansion in Australia. The project would have cost about $15 billion, and increased world uranium production by something like 8 million metric tons a year. The expansion is now being scaled back and delayed, because of the current financial situation.

If we read Cameco's latest report about its mine in Kazakhstan, its report is less than glowing. In describing its new Inkai mine, it reports sulphuric acid shortages, the Kazakh government reneging on the agreed upon tax rate, and an after-the-fact change in the subsoil law.

What does seem to be happening is a grab for available mines by countries like China and Japan. These countries will be needing fuel for nuclear reactors and cannot see good long-term sources of supply. For example, Ranger is the second largest mine in the world, representing 11% of 2007 world production. The Japanaese are trying to get a controlling interest in Ranger and in other mines, according to Japan: Securing Uranium Supply.

China has also been trying to invest in mines. It has been having discussions with BHP Billiton, operator of Olympic Dam in Australia.

The United States believes that the free market will provide and is not trying to buy up assets. Instead, we are trying to ramp up US production, but with little success so far. The US is very dependent on foreign imports, as shown in Figure 7, especially recycled Russian bomb material, which currently makes up 50% of nuclear fuel. Since about 20% of US electricity is from uranium, this means that 10% of our electricity supply is obtained from recycled Russian bombs. Most of the remainder of our nuclear electric supply is from other overseas sources. With current world financial problems, one wonders how secure these sources are. Also, we will need to find additional sources when the Russian bomb contract runs out it 2013.

How Do We Mine the Uranium?

The amount of uranium available depends upon what mining techniques are available and how pollution is handled.

When countries first started producing fuel in the 1950 -1980 period, there was little concern about pollution. Open pit and underground mines were used to produce huge volumes of uranium. Without adequate pollution control, there were often serious pollution problems. Eventually, in the United States, Superfund was called upon to try to clean up many of these sites, and people became disenchanted with this approach to mining. The cost of the Superfund clean-up was never charged back to the uranium industry, so analysts looking at statistics such as EROEI got a more favorable view of the industry than would otherwise be the case.

A USGS Report Issued in 2002 indicates that because of dissatisfaction with the pollution problems of open pit and underground mines, these mines are difficult to get permitted. Instead, most mines now being built are in situ leaching (ISL) mines.

ISL mines can't be built everywhere--only where conditions are right for them. The need to use ISL mines has cut back significantly on the sites available for building mines, but reserve statistics (at least in the United States) don't reflect this. The 2002 USGS report says:

> Future uranium mining in the U.S.A. will be mainly by ISL mining of large reserves in Tertiary sandstone formations in Wyoming, Nebraska, and Texas. Mining of equally large reserves of uranium in Mesozoic sandstone formations in the Colorado Plateau region is less amenable to ISL.

It also says:

> The national uranium resource assessment completed by the DOE in 1980 is significantly out of date. A new Federal assessment, using recent developments in uranium assessment methodology and applying new geologic concepts, would greatly aid future planning for the uranium industry and contribute to the formulation of a national energy policy.

It is likely that reserve estimates for the United States are still using the 1980 DOE assessment, even though it is significantly out of date, and not up to date with mining techniques currently in use.

Clearly, if we were to develop better mining techniques that have acceptable pollution levels and can be used in a wider range of sites, then our ability to extract uranium resources would be improved. As far as I can see, development of additional techniques has not yet happened. Recycled bomb material has been flooding the market for almost twenty years now, keeping uranium prices low. This has deterred investment in better techniques for extracting uranium, both by companies and governments.

The shortfall in supply that seems to be headed our way will be coming very soon--as soon as we become unable to find sufficient recycled bomb material to fill the gap between nuclear reactor needs and current year production, which could be as soon as 2013 (or sooner, if world financial difficulties interfere with imported Russian bomb material before then).

If we need new mines, we should have started years ago, since there is a lag of up to 10 years before a new mine begins operation. If we need new mining techniques, research on these should have started even longer ago. While there may be a whole lot of low level uranium resources "out there", if we don't have techniques to economically extract them and also keep pollution in bounds, the resources are not very useful to us. We may someday develop new techniques, but in the meantime, we are likely to have a large supply gap.