Nuclear Industry Response re. Uranium Reserves

Nuclear industry advocates claim that the supply of uranium is adequate for the foreseeable future, citing:

(1) that the OECD/NEA review of uranium resources, ***Uranium 2003:Resources, Production and Demand*** (more commonly called the Red Book) establishes the adequacy of the supply

(2) that the Red Book data is based on actual physical measurements of the resources as opposed to calculated values employed by some critics of the nuclear program

(3) that the uranium cost is such a small fraction of the nuclear power production cost that the latter is not sensitive to variations in uranium price

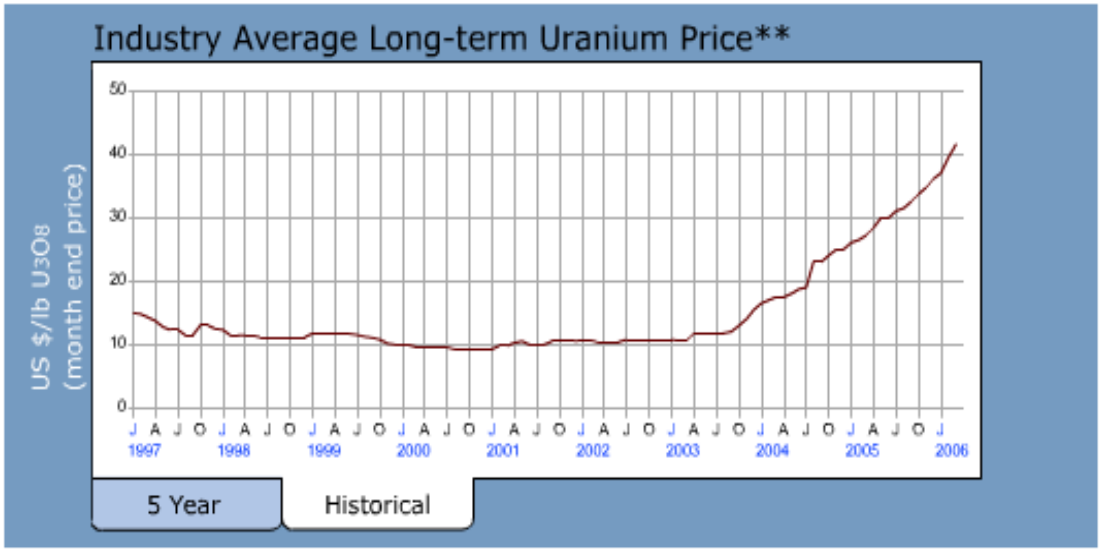
(4) that nuclear power is so inexpensive that there is room for substantial price increases

(5) that the production of greenhouse gases and the consumption of other forms of energy in the uranium production process is not a significant deterrent

(6) that nuclear power is the only large scale competitor to fossil fuels so if we want to reduce our dependence on fossil fuels we must switch to nuclear power, irrespective of the price

Uranium prices

Since both supply and demand are dependent on the price of uranium it is instructive to first look at the price trend. The following graph shows the spot price for uranium over the past 10 years (multiply by 2.6 to convert to $/kg)



Note that the spot price remained stable for a long time but in the past two years has risen dramatically. However, the spot price does not reflect the price paid by most operating nuclear plower plants, which negotiate long term private agreements with individual uranium suppliers. Presumably most plants are still paying about $10 per pound of U3O8 which is probably not much more than the production cost. The uranium mining industry was hit hard by two events – international agreements to convert weapons grade uranium and strategic stockpiles to peaceful uses and the cancellation of the construction of nearly 150 nuclear power stations following the Three Mile Island accident. What the graph shows is a transition from pricing based on cost – any further price decline would have eroded the supply position – to pricing based on market demand.

Market demand

It is anticipated that the demand for electricity will increase by about 40% in the coming 20 years. That implies that the per capita consumption will remain near its current level. A switch away from fossil fuels to almost any of the alternatives, including nuclear, is likely to profoundly affect that projection. If, for example, we replaced fossil fuels with nuclear power then the production of electric power would increase dramatically. If we employ Seasonal Storage then the demand for electricity would drop dramatically, particularly in the summer. If we switched to Ground Source Heat Pumps the demand for electricity would increase.

Although it is widely accepted that we are at a point of fundamental transition, all of the existing energy supply industries are really fighting for the status quo. The OPA recommendations for the nuclear industry is to maintain the nominal nuclear capacity at its present level for the foreseeable future. The coal industry would like to retain its share of the pie. The oil industry would like to switch to tar sands but maintain its market share. The

conservationists have been stung by the recent cancellation of some key conservation programs (even though most projections assume that conservation will be a major contributor to any future energy solutions). All of these existing interest groups are hostile to the entrance of a potential large scale competitor like Seasonal Storage so we are stuck between a rock and a hard place. We know that we need to make fundamental changes but all of the major players are fighting for the status quo.

The world demand for electricity will increase dramatically in counties like China and India, and eventually in other poor counties whose residents presently use little or no electricity. That demand will certainly be much larger than any increase in demand in Canada, and since uranium is an internationally consumed commodity for which Canada is currently the principal supplier the price will be determined by the international demand rather than by domestic demand.

The IAEA attempted to analyze these trends in its report "***Analysis of Uranium Supply to 2050***" (2001). The difficulty is illustrated in their Figure 3, which depicts the short term projections made by many different organizations:

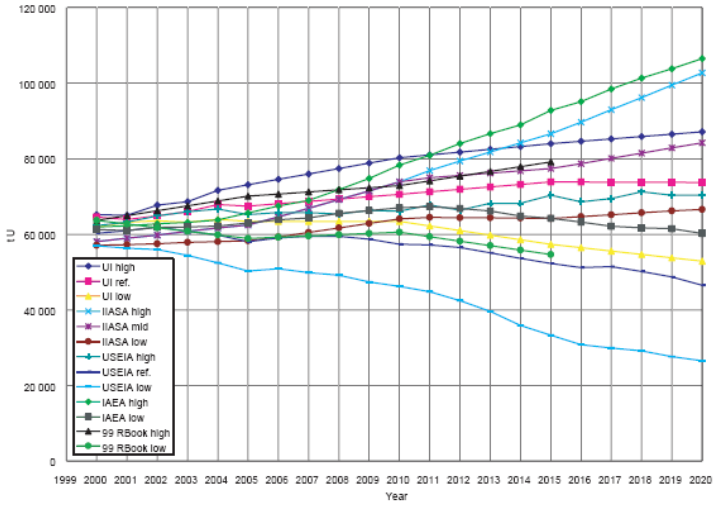


FIG. 3. Summary of previously published projections of annual uranium requirements to 2020.

Their own projections covered the period to 2050 based on three different scenarios:

Low – the existing nuclear plants would be phased out over time
Medium – there would be a modest shift away from fossil fuels to a mix of nuclear and renewable sources
High – the dominant new sources would be nuclear and biomass (assuming "a limited impact of environmental concerns on energy policies")

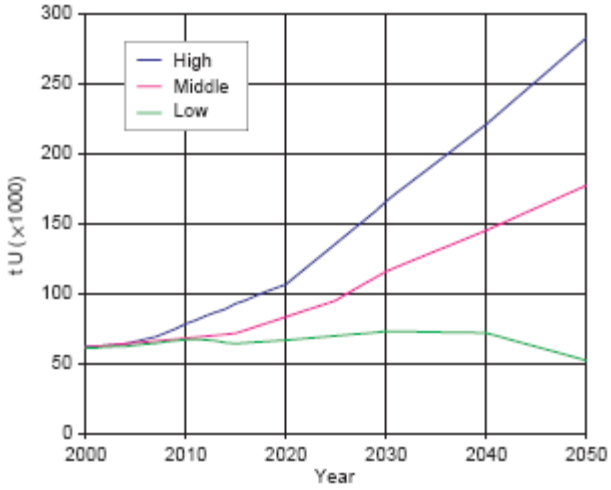
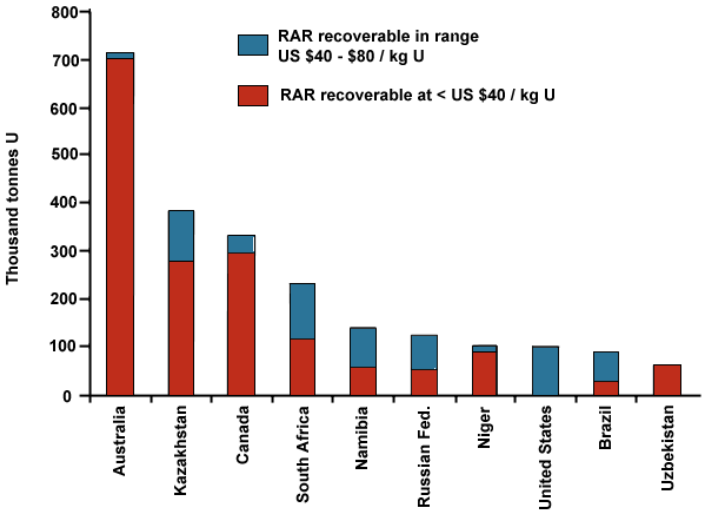


TABLE VI. SUMMARY OF URANIUM REQUIREMENTS FROM FIG. 6

Uranium demand case	Requirements in 2050 (t U)	Cumulative requirements, 2000 to 2050 (t U)
Low	52 000	3 390 000
Middle	177 000	5 394 100
High	283 000	7 577 300

Supply

The following graph shows the Red Book totals for the principle uranium producers covering all of the currently producing mines, plus the properties that are believed to be capable of economic production, including properties for which the cost might be up to $80 (US) per kg.



The total is 3,537 tonnes of uranium, but part of that total comes from countries that reserve all of their uranium for their own use, so it is not part of the available pool. Some such counties (like China) depend primarily on the international pool for their supply. That leaves about 2,800,000 tonnes available.

Nuclear industry claims

(1) ***the Red book shows that supplies are adequate.*** According to the Red Book the supplies are not even adequate to cover the situation where nuclear power is phased out. We would run out of the Reasonably Assured Resource supplies by 2035 in the Medium demand case and by 2025 in the High demand case. Note that even if the High demand objective were met nuclear power cannot come even close to solving the problem of replacing fossil fuels. We need to turn to a higher capacity supply system like Seasonal Storage to achieve that objective, or even to just meet the Kyoto objectives.

(2) ***The Red Book figures are based on actual data*** Any uranium that fits the very broad RAR category is already included in that total, so the balance is made up of calculated values that attempt to estimate what is left in the ground but has not yet been found. The Red Book extensions are just as speculative as the projections of the future costs of developing those resources.

(3) Uranium represents a tiny fraction of the cost The fuel cost varies considerably with the reactor design, but it has been estimated to range between 3% and 40% of the total cost for existing reactors. However, the existing reactors are running on $26/kg uranium while future reactors will run on $109 uranium (the present cost), or possibly much more. The price of uranium is still rising very steeply so we can reasonably expect that if the selling price for power were fixed the cost of the uranium would no longer be a negligible fraction.

(4) ***There is ample room for price increases*** If the fuel prices push up the prices of nuclear power then it is questionable whether the nuclear option is viable, particularly as some of the estimates are questionable to begin with. There appears to be no provision for insurance, which should be included in any comparison even though that cost is borne by the public under the Nuclear Liability Act. There appears to be no provision for dismantling either the existing or the new reactor stations, and no provision for the inevitable cost and schedule overruns. Seasonal Storage offers an alternative that unquestionably could provide more power capacity and that could provide energy on a sustainable basis, so nuclear power does not enjoy a monopoly.

(5) ***The mining energy consumption is negligible*** At the present time uranium is being produced mainly from high grade ores, ranging up to 19%U. The Red Book includes ores ranging as low as .01%. Some low grade ores can be exploited via *in situ* leaching but in the more general case the tonnage of ore to be handled could exceed 1000 times what is needed in current production. Such operations will require a lot of energy from conventional sources to handle such low grade ores, and those sources will add to carbon dioxide production and pollution levels. Attempts by Storm and others to calculate these consequential costs have been met with derision from nuclear proponents who have been quick to criticize but slow to provide credible alternative numbers.

(6) ***Nuclear power is the only alternative*** This claim is absolutely false. The most directly competitive alternative energy sources are the derivatives of solar energy – hydro power, wind power, and heat and electric power delivered by seasonal storage systems. In Canada these sources are already producing far more energy than nuclear plants, and they offer an alternative that is safer, cleaner and that will last for many millenia to come. The wind power and seasonal storage options are barely used at all in Canada. The latter in particular is exceptionally well suited to Canada because our cold winters and hot summers can very directly provide for our energy needs in the opposite seasons.

Conclusions

The OECD/NEA Red Book does not support the contention that we can be reasonably assured that the supplies of uranium are adequate. Indeed the report deals at length with the issue of the deficit in supply over demand. There are presumably undiscovered resources plus the potential to eke out some supply from by product processing of fertilizer, etc., but there is a question about whether such resources can be found and developed quickly enough to maintain the required supply rate and at an acceptable price. It appears to be unlikely that the supply would be sufficient for the planned reactor lifetimes assumed by the OPA. The Red Book (issued in 2003) failed to predict that the spot price of uranium would increase by a factor of 4 in just two years. If the price continues to rise at that rate the viability of nuclear power will be at risk. Countries like China, which has 45 reactors under construction or planned, but which has fewer options for alternate sources of power, will almost certainly maintain the upward pressure on uranium prices. The US is talking about building more reactors. If Canada builds more reactors there is a substantial probability that they will run out of fuel.