

Mr Ilkka Mikkola, Manager, Fuel Procurement, TVO, Finland TVO: Optimal Uranium Purchase Strategy

1. Introduction

In the past we several times carried out studies about uranium purchase strategies. We are sure that many others have also carried out such studies at the buyer's side, and marketing strategies at the seller's side. We usually first sketched several scenarios about future price developments, and then our researcher had to optimise the purchases in those circumstances, say 10 years ahead. The researcher had to find a strategy that worked reasonably well, independent of whatever scenario of the assumed futures would become true. He had to make use of the available company long-term contract portfolio and its flexibilities, and to optimise the use of spot purchases and stocks.

It could be worthwhile to study first forecasts that were made in the past, and strategies that worked when **"the changes in uranium prices had a normal market behaviour"**. After that I will present the most recent study that we carried out two years ago, when **"the future was no longer like it used to be"**. We did not forecast any price developments, as we felt it would be too difficult. Instead, we hired a student to simulate the past 40 years of market prices and to find the best strategy to buy uranium during the past 40 years. The results were surprising, and suggested that something that looks to me like a "Japanese raw material policy" would be the best for very long periods of time.

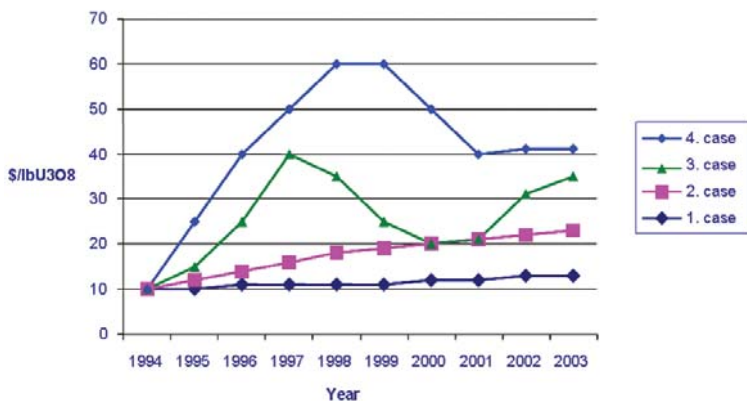


Figure 1: Uranium Price Scenarios, incl. inflation

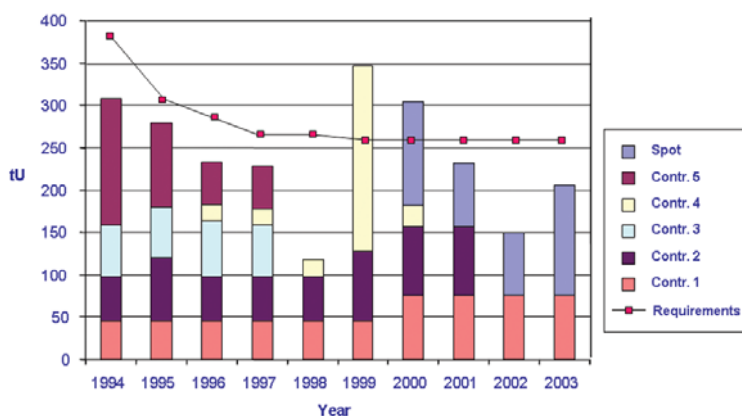


Figure 2: Uranium Requirements and Purchases (Price Case 3)

2. Price scenarios 12 years ago

When we had to undertake strategic studies, we usually let some of our summertime student apprentices do the job. They were usually very bright. For example, they soon realised that the trend of metal prices in the long term was not rising and that cycles in uranium were longer than for other metals. In 1994 we again hired a student to undertake strategic studies. He saw that it would be best to make long-term contracts when spot prices were low, and to try to live with stocks during the times of high prices. This we did, and we had some long-term contracts with rather large flexibilities. Our contract portfolio was five contracts, and the longest of them had a duration of nine years, including the options.

We prepared four price scenarios for him (Figure 1):

- one slump case where the price climbed due only to cost escalation from US\$10/lb to US\$13/lb very slowly within 10 years;
- secondly, where the price steadily climbed to US\$24/lb in 10 years;
- thirdly, where the price went to US\$40/lb in 1997 and came down to US\$20/lb in 2001, and then somewhat up again;
- one wild case, where the price touched US\$60 in 1998-99, and then came down to US\$40/lb.

The model was like this:

- bring stocks to target level by using contractual flexibility range and spot purchases if necessary;
- buy spot uranium instead of uranium within the contractual flexibility range if spot price is, say, US\$2 cheaper than contract price;
- the minimum emergency stock was one year's consumption, i.e. at the top price levels, say at US\$20/lb or more, the target level was one year;
- The target level of stocks was increased linearly towards X years when the spot price was moving down towards US\$10.

The student calculated present values of uranium purchases in different cases, mostly using a 5 % discount rate. A reasonably robust model for all price scenarios was searched for. A rather successful model was such where the target stock level was increased linearly from one year towards the value $X = 2.5...3$ years of forward consumption when the spot price was moving from US\$20/lb towards US\$10/lb.

We show examples of results when using the third price scenario. Figure 2 describes the simulated

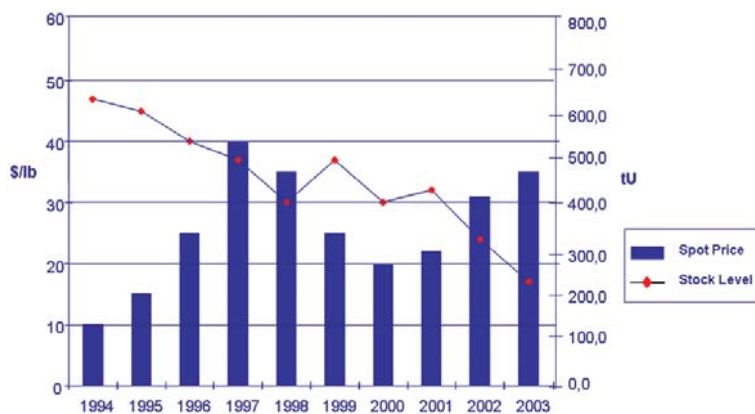


Figure 3: Spot Price and Stock Level Variations (Price Case 3)

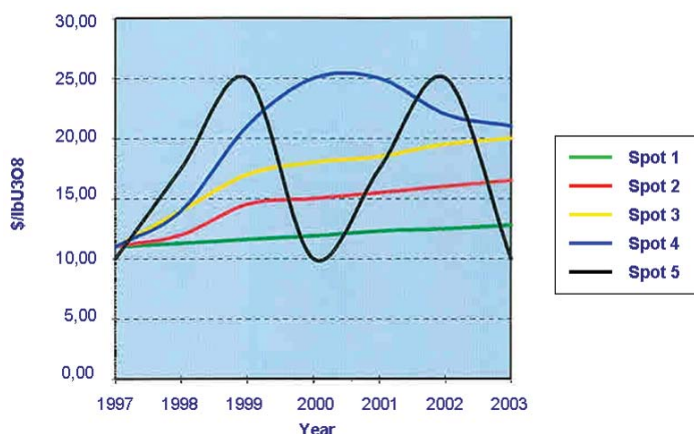


Figure 4: Spot Price Scenarios in 1997

contractual purchases 1994-2003 in the model. It well describes the use of different kind of large contractual flexibilities under contracts in “good old times”. Figure 3 describes the assumed spot price movements in 1994-2003 (scenario 3) and the resulting stock level developments during the simulated ten years.

3. Price scenarios 9 years ago

Over the years we learned from experienced consultants that uranium prices will not go to US\$40 or 50, but will stay between US\$10 and 25. We give an example from 1997 when another student again simulated our strategies and gave good advice on how to make long and short term contracts. Our price scenarios of that time are presented in Figure 4. We realised our biggest mistake here four years later when the spot price went below US\$10. We soon recovered from that shock, however, and purchased in 2001 some extra stock outside the strategy, at the then prevailing spot price about US\$7/lb, and increased stocks a bit over our target level.

4. Optimisation of the purchase strategy for the past 40 years

In 2004 the future was no more like it used to be and we did not forecast any price development. We felt it would be too difficult. Instead we gave our student the task of simulating the past 40 years. His task was to find the best strategy to buy uranium and to optimise stocks by using a minimum present value amount of money during the past 40 years.

We simplified the task by operating with spot purchases and stocks only. The model he used included a minimum emergency stock for one year of consumption (say 1 million lbs) when the spot price was US\$20/lb or more. The stock target was increased in proportion to the spot price decline down from US\$20/lb. At the spot price US\$10/lb or less the stock target reached its maximum value. The maximum stock level was varied from 2 to 10 years of consumption (say from 2 to 10 million lbs.).

Figure 5 presents the case where the maximum stock level is limited to two years of consumption, with a discount rate of 10%. With this limit there was a need to buy many times very expensive uranium in 1977-85. The present value of the money used was US\$4.7 billion.

In the other case, Figure 6, the maximum stock was put to six years of consumption. A lot of expensive purchases could be avoided with stocks, and the present value of purchases was US\$3.61 billion, a cost 33% lower. In fact, the optimum would have been to have stock uranium for 6-8 years at the spot price US\$10/lb, before price increases.

In the case where the discount rate was 5%, the optimal maximum stock level was in the area of 8-10 years of consumption.

In the past many companies rushed to buy uranium when the price went up, and stopped buying when the price came

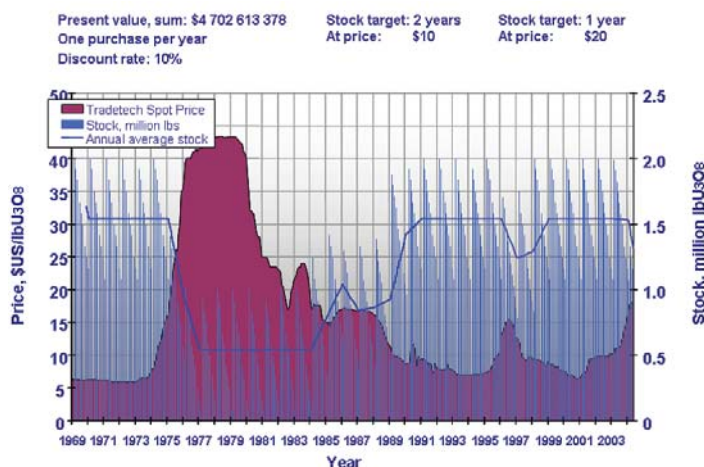


Figure 5: Uranium Purchase Model 1969 - 2004

Present value, sum: \$3 611 579 949 Stock target: 6 years Stock target: 1 year
 One purchase per year At price: \$10 At price: \$20
 Discount rate: 10%

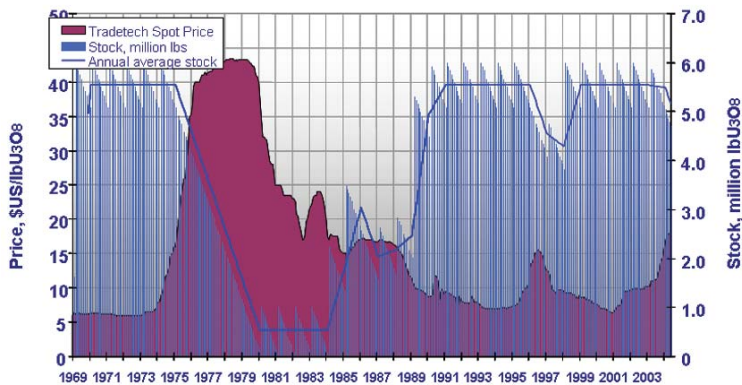


Figure 6: Uranium Purchase Model, Annual Needs = 1 million lbs

down. After this paper it is clear that sensible buyers will stop buying when prices go to unreasonable heights, and only begin to buy when the price again is reasonable.

The problem is what is “reasonable”. Maybe the above window, US\$10-20, is in any case now gone. And the ‘Ontario Law’ is very helpful here. In cases where there is no price in the contract, for example, when you have to negotiate the price annually, the ‘Ontario Law’ stipulates the following: “The price has to be reasonable. What is reasonable depends on circumstances around each particular case.” How clever the lawyers are!

5. Conclusions

The second study shows in a very simple way how important a stock policy is, or actually would have been during the past 40 years. By using stocks the user may avoid spot purchases when prices are high, and situations where he is forced to make very unfavourable long-term contracts.

The first study shows how beneficial it is to have a portfolio of long-term contracts with different terms, negotiated every now and then, and combined with a stock policy. The user’s portfolio of long-term contracts reduces the size of the stocks optimally needed, as we saw in the first study, but even in that case it is worthwhile increasing stocks to levels equivalent up to something like 2-3 years of forward consumption when uranium prices are so low that they do not support enough production.

The even more important feature of long-term contracts is to create enough supply, preferably oversupply. Oversupply eventually is the only device that limits price rises and will finally take the spot prices down.

If all users and all suppliers have a sensible stock policy, then price fluctuations will be smaller. “Just on time” and “zero stock” policies have created susceptibility to price fluctuations. Stocks serve the purpose of stability. We do not know to what extent history will be repeated, and these

examples are quite simple, but they illustrate some basic points about strategies.

We will see if we ever learn from history. Also, real life has many aspects. It may well be that there are in the markets some much more intelligent groups than the simple power company people, intelligent people who prefer complicated strategies and large price fluctuations.

Acknowledgements:

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