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The Global Nuclear Fuel Market – Supply and Demand 2005-2030. WNA Market Report

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Introduction

Ladies and Gentlemen: today I would like to report on the WNA Market Report, which was investigated, analysed and drafted by a dedicated sub-group within WNA.

The Nuclear Fuel Working Group, chaired by Mr George Capus of Cogema, judged in September 2004 that the WNA Market Report should now be updated, given that the report had been revised every two years in the past and because the supply and demand situation had changed since the last issue in 2003. After this decision, a new sub-group, called the " Market Report Drafting Group " was established, and it completed the report just a few days ago. What I will discuss today is all contained in the 2005 Report, which will be available to every WNA member company. Therefore, you don't have to take notes today!

Drafting Group Members:

WNA Members	
•Mr Harry Maeda (Chairman)	ITOCHU International
•Mr Jérôme Bonnet	COGEMA
•Mrs Penny Buye	Cameco
•Mr Andrew Crockett	Urenco Enrichment Company
•Mr Claus Fenzlein	Framatome ANP
•Mr Shuji Matsumoto	Mitsubishi
•Dr Arthur Max	RWE Nukem
•Mr Kenneth Petersen	Exelon
•Mr Jaroslav Sedina	CEZ
•Mr Patrick Signoret	COGEMA
•Ms Nichola Still	Westinghouse UAM
•Mr Eric Webb	Ux Consulting
•Mr Michael Whitehurst	USEC

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WNA Secretariat

•Mr Stephen Kidd (Secretary)	Director of Strategy and Research
•Ms Irina Borysova	Research Officer
•Mr Satoshi Tachibana	Visiting Research Officer
•Mr Martin Taylor	Consultant

As you may be aware, this Report is used not only by our industry people, but also by outsiders, in the financial sector, consultancies – even by anti-nuclear people. In order to satisfy all of these people, an accurate, neutral, trusted and useful report is required. Therefore, we collected expertise from many knowledgeable members, both utilities buying nuclear fuel and their suppliers, and also from the three biggest nuclear power regions, Europe, North America and East Asia.

The work of the drafting group required a lot of cooperation from the members' headquarters companies as well. Please see the names of the group members on the slide and also the Secretariat staff responsible. I would like to thank everyone very much for their efforts.

Report Structure

Now I would like firstly to mention the report structure. Please look at the report index.

Report Contents:

Executive Summary
1. Introduction
2. Nuclear Generating Capacity
3. Nuclear Fuel Demand
4. Nuclear Fuel Supply
5. Supply, Demand and Conclusions

References
Appendices

The report consists of an Executive Summary, followed by five chapters. We decided to maintain the structure as used in the 2003 report. In other words, we decided to maintain from the 2005 Report the main divisions of Nuclear Generating Capacity, Nuclear Fuel Demand, Nuclear Fuel Supply, and Supply, Demand and Conclusions.

To follow this decision, we firstly studied each country's nuclear generation programme and updated our forecasts. This was mostly completed by April, and the drafting of the words was completed in parallel. This is discussed in Chapter 2 of the report.

After we developed the big picture of nuclear generation programmes over the world, the demand for uranium and the fuel cycle services such as conversion, enrichment and fabrication were reviewed. In this review, some careful analysis was necessary and decisions made. This included nuclear power plant design, reactor load factors, cycle length, tails assay, burn-ups and so on. This is discussed in detail in Chapter 3 of the report.

Then, a review of supply sources was made. This was developed by dividing the supply into that from primary uranium production and from secondary supply sources. This is discussed in Chapter 4.

Finally, Chapter 5 discusses the balance of supply and demand, and reaches some conclusions.

Nuclear Generating Capacity

Now let me talk a little about the essence of the report. This report covers the period until the year 2030. This is because we believe that a nuclear generation programme always needs a long-term plan, but beyond 2030 is too far to project.

In order to make a demand forecast we needed a forecast of nuclear generation capacity in each country. Here, we set three cases, optimistic, pessimistic, and neutral to the capacity forecast. We call them the upper scenario, the lower scenario and the reference scenario.

We forecasted the capacity before 2020 based on the currently known plans or programme in each country. Regarding the capacity forecast after 2020, we did not review it in each country. We reviewed it region by region up to 2030 based on the trends apparent before 2020. Of course, we considered possible plant closures which may occur before 2030, given possible license expirations, government policies or financial pressures.

Figure 1 shows the capacity forecast (this is Figure 2.3 in the Report).

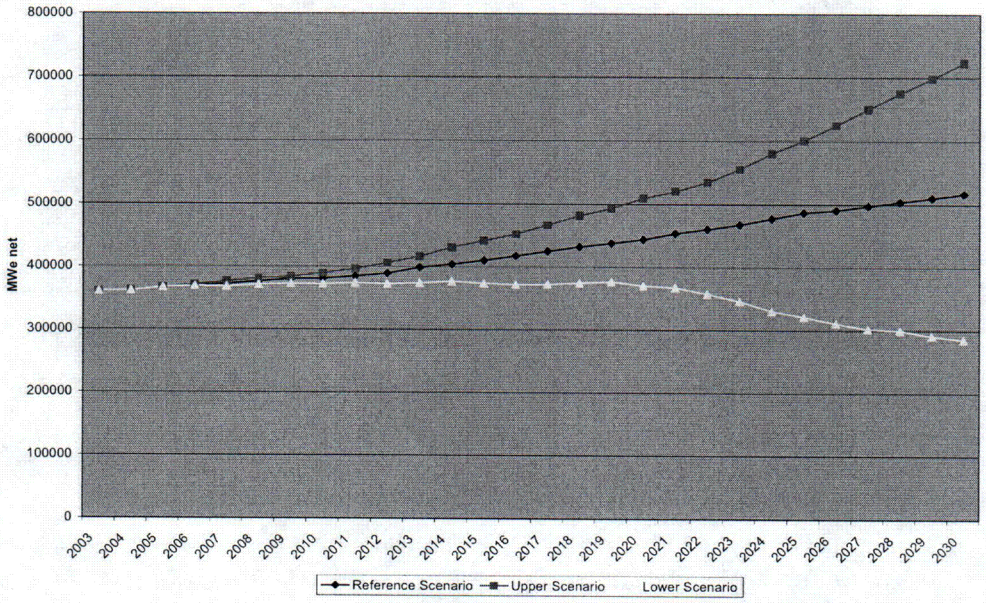

Figure 1. Nuclear Generating Capacity to 2030.

In 2020 under the upper scenario, we estimate the nuclear capacity to be approximately 520 GWe. This shows a growth of 41% as compared with the year 2005. This represents 2.4% average annual growth during the period.

In 2020 under the lower scenario, we estimate the capacity to be approximately 365Gwe. This is almost the same capacity as now. In another words, it is zero growth as compared with now.

In 2020 under the reference scenario, we estimate the capacity to be approximately 445 GWe. This shows a growth of 21% as compared with the year 2005. This represents 1.3% average annual growth during the period.

What I want to stress under the upper scenario is the growth in East Asia; ahead of all others, it is Mainland China. Under this scenario, about 30GWe of increase is expected to occur there and it accounts for additional 30 reactors of the current popular size of around 1000 MWe. As a matter of fact, China has started up several new reactors since 2002, and the expected growth there is not a dream at all. Also the Report expects about 12GWe growth by 2020 in India, where the economic boom continues, and about 20GWe growth in Japan, where the population is now expected to decrease.

Under the lower scenario, on the other hand, many reactors are expected to shut down in some countries. Good examples are Germany and the United Kingdom. Anti-nuclear policies and opinion are expected to continue, with no new plants expected, while some reactors will be forced to shut down earlier than scheduled. However, we still estimate a certain growth in China, Korea, India and some countries in this scenario.

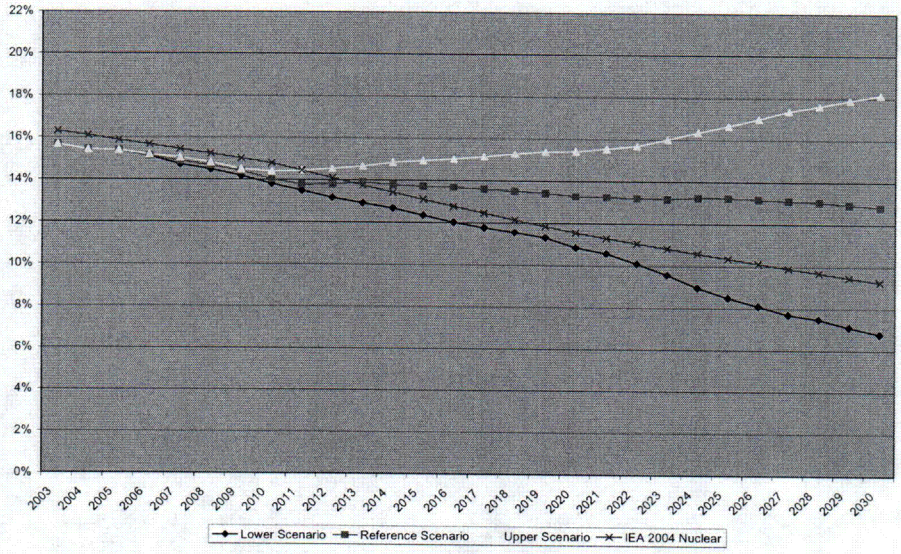

Figure 2. Nuclear share of power generation, %

Just for your reference only, we show a nuclear generation capacity forecast issued by IEA in 2004. This shows a decrease in the share of nuclear generation among all power generation. The main reason why IEA project such a decrease is because they expect most of old aged reactors in Western countries to retire without license extension, which I don't believe will happen.

The IEA reference scenario expects about 1.7% annual growth in energy demand for the next 20 to 30 years, and that electricity demand will grow at 2.45% per year as the electricity demand will increase more rapidly than the energy demand.

This 2.45% growth is coincidentally the same growth as the growth in nuclear generation capacity up to 2020 under our upper scenario. Now you can understand that from the standpoint of the electricity demand increase, our nuclear generation

capacity growth under the upper scenario is not too optimistic. I would rather say a sort of realistic scenario.

Nuclear Fuel Demand

Based on the nuclear generation capacity forecast, we estimated the demand for uranium, and the other fuel cycle services towards 2030. In this estimate, we included some reasonable assumptions on nuclear reactor designs, load factors, cycle lengths, tails assays, and others. These are the influencing factors on the demand forecast.

Factors affecting fuel requirements

- Reactor designs
- Load factor
- Enrichment level
- Fuel burnup
- Tails assay
- Cycle length

Here, I would like to make an additional explanation about the tails assay. Lower tails assays will produce more enrichment requirements with a lower uranium feed. The recent uranium price increase has already led to utility companies specifying lower tails assays with enrichment companies. The most economic tails assay to utility companies under the current spot price for uranium, conversion and enrichment is somewhere around 0.25%.

However, we choose 0.27% as our model tails assays. This is because 0.3% or higher tails assays are still projected by many utilities according to our recent questionnaire. However, our report provides a detailed sensitivity analysis for various tails assays, instead.

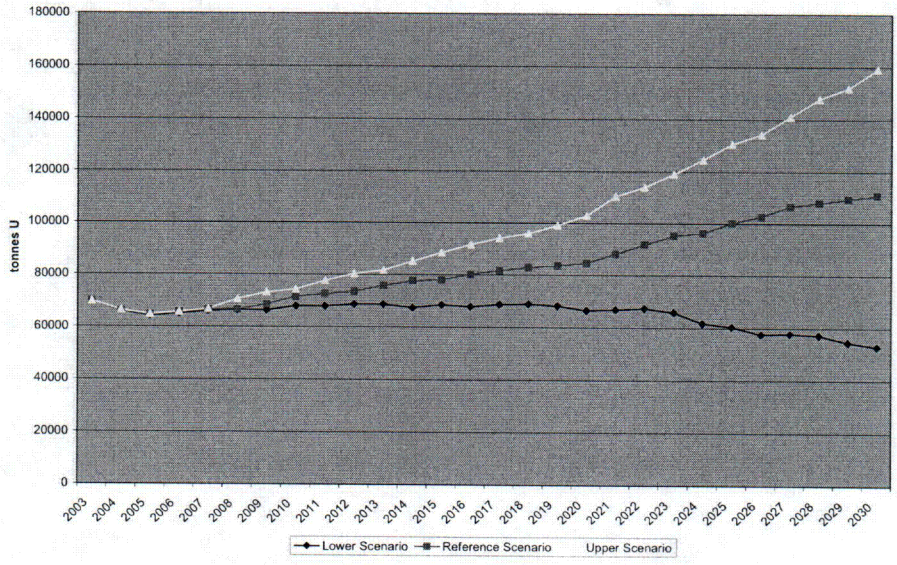

Figure 3. Uranium requirements to 2030, tU (Figure 3.3 in the Report)

Here are demand curves for uranium and enrichment services only. These are similar to the curves we saw earlier for the nuclear generation capacity increase.

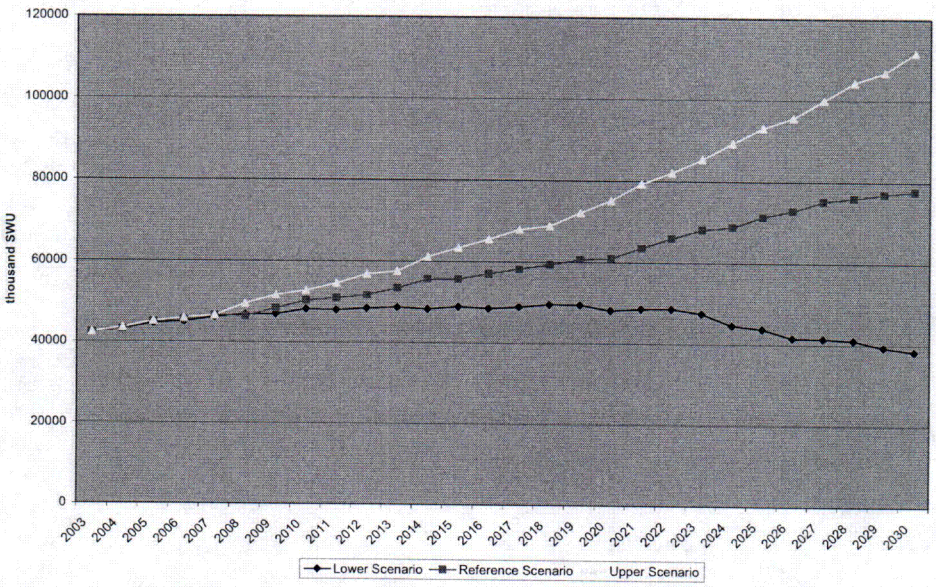

Figure 4. Enrichment requirements to 2030, '000s SWUs

Nuclear Fuel Supply:

- Uranium
- Conversion
- Enrichment
- Fuel fabrication
- Primary versus secondary sources

Now I will talk about supply. We estimated nuclear fuel supply component by component, such as uranium, conversion, enrichment and fabrication. Also we considered it not only from primary production, but also from secondary supply sources, such as inventory.

Table 1. World uranium production 2004-2004, tU (Table 4.2 in the Report)

	2002	2003	2004	% change 2003-2004
Australia	6854	7572	8982	19
Brazil	270	310	300	-3
Canada	11604	10457	11597	11
China*	730	750	750	0
Czech Republic	465	452	412	-9
France	18	9	7	0
Germany	212	150	150	0
India*	230	230	230	0
Kazakhstan	2800	3300	3719	13
Namibia	2333	2036	3038	49
Niger	3075	3143	3282	4
Pakistan*	38	45	45	0
Portugal	2	0	0	0
Romania*	90	90	90	0
Russia*	2900	3150	3200	2
South Africa	824	758	755	0
Spain	37	0	0	0
Ukraine*	800	800	800	0
USA	883	779	878	9
Uzbekistan	1860	1589	2016	27
Total	**36025**	**35622**	**40251**	**13**

*WNA estimate

Currently, annual uranium production is approximately 40,000 tU. The significant price increase for uranium over the last couple of years has increased 2004 production by about 4,000 tU per year compared with 2002. This price increase is still expected to last and many uranium mining companies plan to develop new uranium mines.

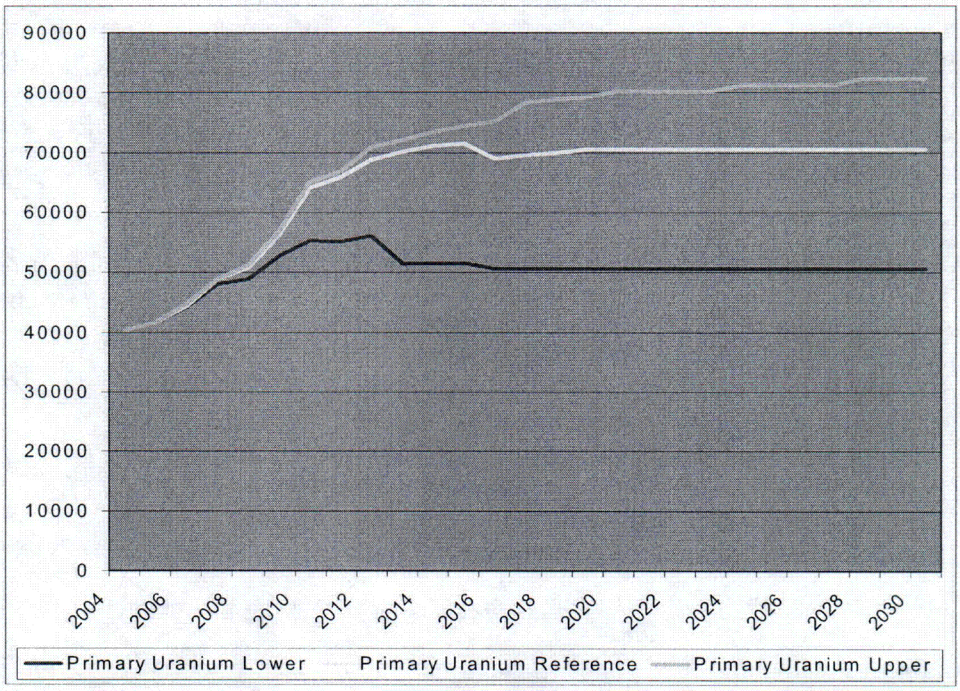

Figure 5. Expected world uranium production capacity, 2005-2030, tU. (Figure 4.5 in the Report)

This is a future uranium production projection. Here we considered existing uranium production facilities continuing in production at the recent level unless they announce otherwise. Also we have taken new mines into consideration as well. And we set three scenarios again upper, reference, and lower scenarios. Under the lower scenario, approximately 50,000 tU production per annum is projected. And 70,000 tU per annum and 82,000 tU per annum are projected under reference and upper scenarios, respectively. We are saying that the extraordinary period will continue for the next 15 years or so, with uranium production never catching up with its demand level – so secondary supplies will remain important.

Secondary Supply:

- Commercial inventory
- Government inventory
- Ex-military materials
- Reprocessed uranium and MOX fuel
- Re-enriched depleted uranium

Other than uranium production, we should not forget secondary supply sources such as commercial inventory, governmental inventory including HEU feed from the Russian government, ex-military uranium, reprocessed uranium, plutonium and re-enrichment of depleted uranium. The analysis we did this time found that the commercial inventory has been almost maintained from the previous report

analysis, which is approximately 110,000 tU, 150% of world annual consumption. This tells us that we don't rely on such commercial inventory nowadays. This tendency will continue, or the inventory will possibly be built up again in the short term.

Government inventory is also a very important supply source in addition to the commercial inventory. Most of the government inventory is HEU feed supply from Russia. Currently, the equivalent of approximately 9,000 tU per annum is being supplied and this will continue by 2013. A big question is whether this will stay the same after 2013 or not. This will be probably decided NOT by economic reasons, but by political reasons between US and Russia toward 2013. Therefore, this is very difficult to foresee it at this point of time. Our report estimates 2,000 tU per annum to be supplied after 2013 under only the upper scenario.

With regard to conversion, enrichment, and fabrication, we just report the current capacities and future projected capacities which have been already announced. Russian HEU Feed supply contributes a lot to conversion and enrichment here again.

Supply and Demand:

- Russian-origin reactors
- Western-origin reactors
- Combined to produce world picture

Now let uss see the position of supply and demand based on what I have told you.

Before we come into the details, I need to emphasise that historically the nuclear fuels business has been divided into two fields. One is where Russian origin reactors have been built, including Russia and the Newly Independent States (NIS) and the countries of Eastern Europe. The other one is the remainder of the world, where Western type reactors have been built. More recently, these segments have become mixed, but the flow of uranium or its products has been mainly one way. Therefore, we again analysed supply and demand in the two sections, later bringing together the two sections to see the whole world situation. Today I will just report to you only the reference scenario among the three supply scenarios, for reasons of time.

Uranium

Let's take a look at the three demand scenarios for Western reactor types.

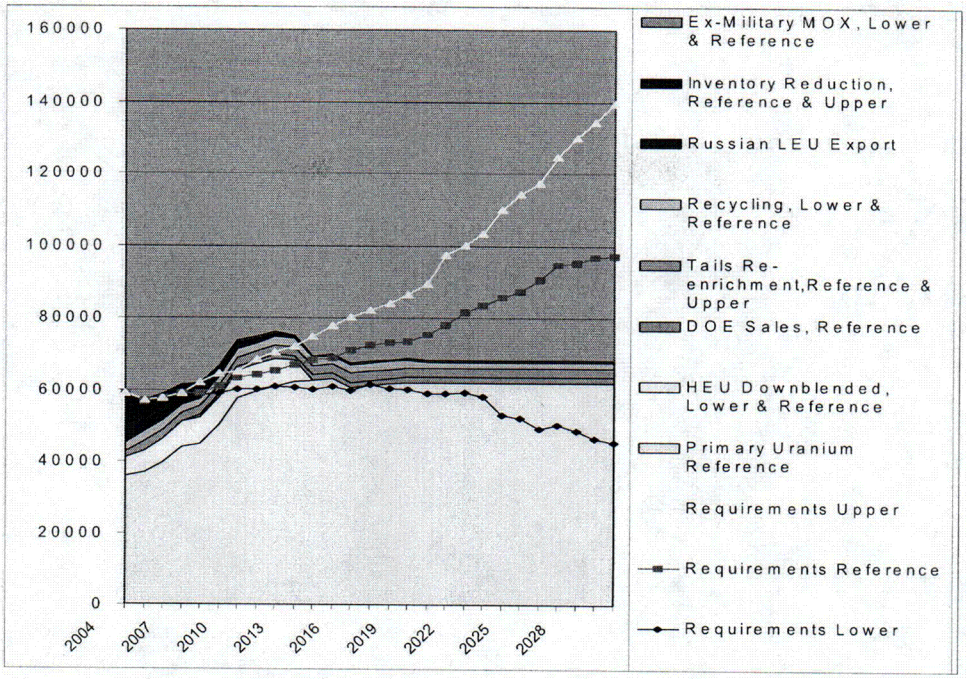

Figure 6. Western-origin reactors and reference case supply (Figure 5.2 in the Report)

Our report concludes that uranium supply satisfies all demand scenarios until 2015 or so. Towards 2015, the production will increase from today's level, but the supply from secondary sources will decrease and the demand will not be covered in 2015. After 2015, the growth in production will slow and the gap between supply and demand will widen, except in the lower demand scenario.

Next, please look at the situation with Russian-designed reactors.

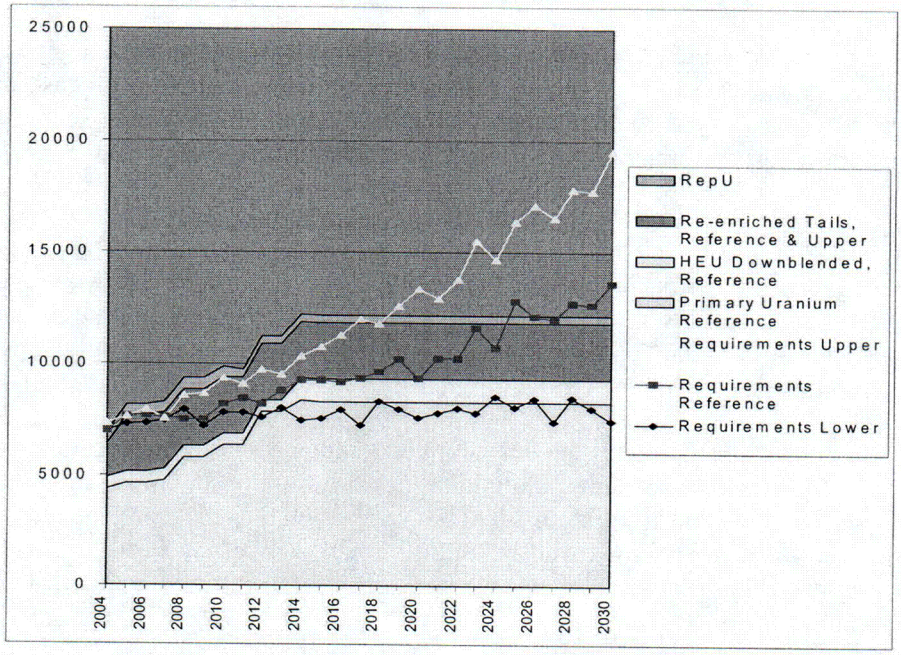

Figure 7. Russian-origin reactors and reference case supply (Figure 5.6 in the Report)

Unlike for Western reactors, it looks OK until 2020, except in the upper demand scenario.

Now let us take a look at the whole world picture, assuming that the uranium flows continue between the two separate markets.

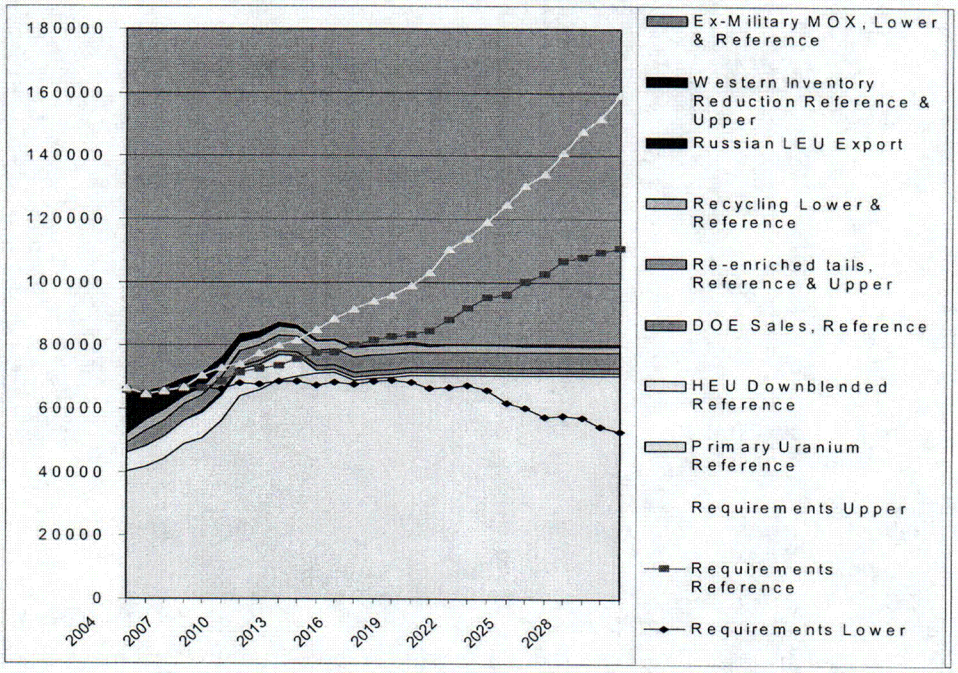

Figure 8. World reactors and reference case supply (Figure 5.9 in the Report)

Again, there is likely to be a significant gap between supply and the demand between 2015 and 2020. This is because of the large demand increase in Western countries. If the lower demand scenario occurs, this is not going to be a problem.

Let me repeat. Our upper or reference scenarios are not too optimistic. Our upper demand scenario cannot meet the overall electricity demand growth forecast in the reference scenario by IEA. In another words, in my opinion, our upper scenario in demand probably has much higher probability than our lower demand scenario.

Conversion

Current production capacity in conversion is 62,000 tU in UF_6 and 4,000 tU in UO_2 respectively. This is almost meeting the current demand, although actual capacity does not run at 100% and the gap is filled with secondary supply sources. However, this is a much better situation than current uranium supply and demand.

In 2020, our Report estimates that UF_6 conversion demand will increase to 80,000 tU under the reference scenario, while the secondary supply for conversion will be unstable as well as that for uranium. Therefore, we believe that more capacity will be required for conversion as well in long term. Of course, the addition is not so easy. But if our industry gets together to aim for it, I don't think it's so difficult as for uranium.

Enrichment

On the other hand, current production capacity for enrichment is large enough to cover current demand. This seems to be good news. However, this market is rather oligopolistic with few sellers. If a part of supply is interrupted for whatever reason, we can see all of sudden a shortage.

As a matter of fact, there will be a shortage of capacity after 2010 if demand increases as planned. Secondary supply will fill the gap here again, but we don't know what it will be after 2013.

To make a long story short, for enrichment after 2013, we are very much dependent on the Russian HEU feed supply. If we want to avoid any unstable situation where we rely on the Russian HEU, we might need to add more capacity before 2013.

Fabrication

Fabrication is the most stable market right now, compared with the other fuel cycle markets. One interesting area here is the amount of MOX fuel fabrication plant. More capacity will be necessary if we are to see more MOX usage, which will be the case under our upper scenario.

Conclusion

In conclusion, we now reconfirm our previous Market Report conclusion that the fuel supply is potentially short beyond 2015, unless the lower demand scenario occurs. In particular, future uranium supply is now a big issue. Actually, the uranium market has been concerned about it for some time and accordingly, the price has been increasing for the last couple of years. Primary uranium production now needs to rise sharply to meet market demand.

One of our concerns is that uncertainties about fuel security in the future may depress possible investors' confidence in the nuclear power industry. This could potentially delay or cancel the nuclear programmes, currently set.

In order to mitigate such issues, in my personal opinion, I believe that more governmental inventory could be released and public support for additional uranium production capacity should be achieved.

Lastly, we had some restrictions in writing this Report, such as time constraints, model simplifications to easily understand, taboos of price expectation and so on. Therefore, we cannot say that this report is 100% correct. Some of you may have more precise data, or details. Such people may use our Report as a just base data to be modified as necessary. However, we are confident that our Report hits the mark more or less. Uranium supply needs to increase substantially to meet market demand and constraints that prevent this have to be removed.

A copy of this Report will be sent to each member company. If you want additional copies, please let the WNA office know – a reasonable number of copies will be made available free of charge.

Thank you very much.

