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## **Government's Role in the Fuel Cycle: An American Perspective**

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### **Introduction**

We work in an industry that was borne of government military programmes. The awesome power of the atom that Einstein warned could be unleashed to destroy the world, history has shown could also be harnessed for peaceful purposes – powering industry, development, and modern life in all its facets. So it is appropriate that here, on the 50<sup>th</sup> anniversary of Eisenhower's Atoms for Peace address, we acknowledge and celebrate that which has come from such a terrifying chapter in world history – the first time that man had developed the capability to destroy himself. Hopefully with the changes of the last decade, we have turned away from that precipice, and perhaps upon the violent history of the last century can be built the foundation for a more peaceful, prosperous and environmentally responsible world. Nuclear energy has an important role to play in such a world.

As governments enabled the birth of the Atomic Age, they also have a continuing role to play in supporting the peaceful use of atomic energy. In the United States, in contrast to many other countries, the government does not play a large central role in planning future energy policy. As you know, Americans are strong believers in free-market approaches to problems, perhaps at times to a fault. Yet this can be problematic for long-term policies, because purely free-market approaches always tend to seek the lowest-cost alternative. Hence we have seen the continuing choice of natural gas for new power plants built in the US – cheaper and faster to construct, politically acceptable, and not as bad on the environment as coal and oil. But if there is to be a nuclear renaissance – and future energy and environmental expectations demand that there be – then forward-looking government policies are needed to help us get there. We have seen some encouraging signs in this regard of late, with the Yucca Mountain legislation last year, and support for new reactor construction in the Senate. Most importantly, we cannot forget the role that the power industry has played in improving operation of nuclear plants to the degree that they are now competitive with all other forms of generation.

But is there, or should there be, a role for the US government in the nuclear fuel cycle? More so than most other countries, the US advocated a private-sector approach to uranium mining and processing at a very early stage. Incentives were

provided to encourage companies to enter the business and get it off the ground. A regulatory regime was constructed that allowed private companies, from the largest oil multinationals down to cowboys with Geiger counters dropping bags of flour from airplanes, to enter the business to compete in supplying the nation, and other nations, with nuclear fuel. While the industry has suffered through tremendous boom and bust cycles, the theory of comparative advantage of nations is fully at work – some fuel infrastructure remains in the US, such as conversion, enrichment and fabrication, but most uranium mining activities have been concentrated in those countries with the richest deposits, and thus the lowest cost. This is as it should be, in our view.

The exception was in enrichment, where because of its strategic military overtones, the US government retained its involvement until just a few years ago. With overcapacity and the end of the Cold War, the government saw fit to sell off the aging US enrichment enterprise. But only five years after that privatization, the government may be needed to support the construction of a new, lower-cost enrichment plant in the US. Should it do so? And exactly where do the lines between national security, energy security, environmental policy and private industry intersect? More importantly, now that reactor lifetimes are being extended well into the middle of this century, and new plants may be ordered in the not too distant future, is it the role of the government to assure there will be adequate supplies of fuel for these plants in ten, twenty, thirty years? Or is that responsibility properly left to the industry itself?

In this Paper we will try to answer those questions and discuss what role the US government may play in the nuclear fuel cycle in the future.

### **Evolution of the government's role in nuclear fuel**

While the US government is often thought of in the context of the enrichment enterprise, it actually has a long legacy of involvement in the uranium market as well. It is interesting to examine the evolution of the government's role in the US uranium and enrichment industries to see how markedly things have changed since the early days of the US nuclear industry (*Figure 1*).

The US nuclear fuel cycle was developed in the 1940s to support the US military programme. Three enrichment plants using gaseous diffusion technology were constructed between 1943 and 1955, with output devoted entirely to military purposes. On the uranium front, the US government initially imported the uranium it needed for its nuclear weapons programme, as a shortage and poor quality of uranium ore in the United States was noted in the letter from Einstein to President Roosevelt that launched the US programme. In order to stimulate uranium production in the US, in 1948 the newly formed Atomic Energy Commission announced that it would pay US\$3.50 a pound for "high-grade" ore for a period of ten years, as well as a US\$10,000 bonus for the discovery of high-grade deposits in the US.

The government's uranium purchase programme was hugely successful, with purchases peaking at 70 million pounds  $U_3O_8$  per year in the 1950s. In fact, it proved so successful that the government instituted a moratorium on new

purchases from US producers, and announced that it would stop purchasing foreign uranium. To prevent the foreign uranium industry from collapsing entirely, the government conducted a “stretch out” programme of purchases. Recognising that the emerging commercial US nuclear power industry would need a base of production, the government later instituted a stretch programme in the US where it continued to purchase domestic uranium until 1971.

The US government had other ways in which it supported domestic uranium production in the dawn of the commercial nuclear power era. In 1964, it amended the Atomic Energy Act to allow and eventually mandate the private ownership of special nuclear material (prior to which, utilities operating nuclear reactors had to lease fuel from the government). However, the government maintained ownership of the enrichment facilities because of their military significance. It instituted an embargo on the enrichment of foreign-origin uranium for US reactors, and because the US had a virtual monopoly on providing enrichment services at the time, the embargo effectively protected US uranium producers from competition. This embargo remained in place until 1977, when US utilities were allowed to meet 10% of their needs with foreign uranium. However, by this time, the uranium price was already over US\$40, and US production was expanding. US uranium production continued to increase, peaking at 43 million pounds U<sub>3</sub>O<sub>8</sub> in 1980.

In order to assure future supplies of uranium, during the 1970s the government undertook a comprehensive effort to explore the United States for uranium through the Natural Uranium Resource Evaluation programme. That programme ended in the 1980s. In the 1990s, the government temporarily rescued the domestic uranium industry through enforcement of its antidumping trade laws, but uranium no longer held a special status. US uranium production continued to shrink, and it now stands at about 2 million pounds U<sub>3</sub>O<sub>8</sub>, compared to US requirements that currently approach 60 million pounds.

Of course, as large an influence that the government had when it came to uranium supply, it played an even more direct role with respect to enrichment. Uranium production was essentially in the control of private companies, although the government certainly had an impact on the market through the stimulative and protective policies noted above. But as the owner of the enrichment enterprise, SWU production and contracting policies were entirely controlled by government actions and policies. It ran the plants in such a way not only to support the domestic nuclear power programme, but also to support its non-proliferation policies. As a virtual monopolist supplier in the early commercial years, this afforded the government a considerable amount of power.

The unpredictability of the government’s early commercial enrichment business was a source of consternation to nuclear utilities worldwide. The US closed its order books several times during the 1970s, and this caused utilities to take unusual actions, like signing contracts for reactors that were only on the drawing board, for fear of being short of supply. Such unpredictable contracting policies prompted the formation of the Urenco and Eurodif consortiums, and caused European utilities to seek supplies from the Soviet Union. Ultimately, this created more market competition, and forced the US government to rethink its contracting policies and its entire approach to the market.

## **Enrichment privatisation**

The US government first entertained the idea of privatising its enrichment enterprise in 1969, shortly after President Nixon took office. During the Nixon and Ford administrations a number of initiatives were undertaken to facilitate the privatisation of enrichment, including industrial participation programmes and Congressional hearings. Private contractors played an essential role in the US Gas Centrifuge Enrichment Programme (GCEP). However, GCEP was eventually scrapped in the 1980s, when it was deemed that expansion of enrichment capacity was not needed, and laser enrichment (AVLIS) was thought to represent a superior technology. Of course, USEC later scrapped AVLIS when it deemed that AVLIS was not commercially feasible, and is now in the process of resurrecting the GCEP technology as the basis of its future centrifuge plant.

Privatisation resurfaced in the late 1980s and early 1990s when it became evident that a private entity would be better able to compete in the emerging global enrichment market and to commercialise a new enrichment technology. The US government had a woeful track record on both accounts, as it was losing market share and was spending massive amounts of money on technology with little in the way of demonstrable results.

While efforts to privatise the enrichment enterprise picked up steam, it is important to note that privatisation was not completed until it was clear that the Cold War was over and enrichment capacity was no longer needed for military purposes. The true reversal of the nuclear arms race was marked by the advent of the highly enriched uranium (HEU) deal between the United States and Russia. In August 1992, President Bush announced that the United States and Russia had agreed in principle for the US to purchase Russian HEU. Two months later, in October, the Energy Policy Act of 1992 was passed, creating the United States Enrichment Corporation as a government corporation with the requirement that a privatisation plan be prepared within two years after the transition date. Also, the US-Russian Suspension Agreement was signed that same month, and it covered HEU products even though the government-to-government agreement and the implementing commercial agreement on HEU were not to be signed until the next year.

It is interesting to note that the HEU deal represented the literal fulfillment of Eisenhower's vision expressed in his "Atoms for Peace" speech, which stated: "It is not enough to take this weapon out of the hands of the soldiers. It must be put into the hands of those who will know how to strip its military casing and adapt it to the arts of peace." At the same time, it paved the way for the government to exit the enrichment business. The shift in the government's focus was now complete: instead of focusing on production of enriched uranium, the government turned its attention to getting rid of HEU, which necessarily meant reducing production so these supplies could find a home.

## **USEC and the HEU deal**

While privatisation was, in essence, made possible by the fact that the government no longer needed to produce HEU, it did present an interesting challenge when the government sought to liquidate HEU supplies. After agreeing to purchase LEU produced by blending Russian HEU to reactor-fuel level, the government then turned to the commercial market to mitigate the financial burden to taxpayers. USEC, as the only domestic enricher, was chosen to distribute the SWU component of this new supply. Despite some subsequent criticism, this decision appeared to be the logical choice given USEC's high production costs and substantial sales contract portfolio.

The end result is that today, USEC, while a fully private company, fulfills a somewhat unique role in the market. As the company responsible for implementing the HEU transaction, USEC is heavily involved in a vital government non-proliferation programme. The fact that most of USEC's profit margins actually come from its markup on the Russian SWU it re-sells, rather than on its own production, has been criticized as opportunistic, and perhaps unfair to Russia. However, it is an incidental concern in the eyes of the US government. The government relies on USEC to help fulfill a critical national-security mandate, even though it has less leverage over USEC than it had when USEC was a government-owned entity. Of course, the most significant leverage the government does have is the ability to take away USEC's role as Executive Agent. As looking at USEC's financial statements will attest, that is a rather strong incentive indeed.

To be fair, the US government has not completely given up on domestic enrichment supply, as DOE has set minimum production targets for USEC's Paducah plant and established milestones that USEC must meet in constructing a new centrifuge enrichment plant using US technology. At stake for USEC is its future role as HEU Executive Agent, among other things.

But in contrast to, for example, Cogema, the US government is not in a position to assure that USEC builds a new facility. In the French case, as a government-owned company, Cogema is by extension fulfilling the French government mandate. Although the new plant is likely to be financed with ongoing SWU revenues and retained earnings from the Georges Besse plant, one way or another the full faith and credit of the French government stands behind the operation. So Cogema faces fewer uncertainties regarding its new centrifuge plant compared to USEC – most of the French uncertainties are related to the exact nature of the technical cooperation with Urenco, rather than the financial viability or internal justification for the facility.

USEC's situation is clearly different. Everyone agrees that USEC needs a new, lower-cost production facility in order to survive. But on the face of it, that is USEC's problem, not the government's. It will be up to USEC to complete the technology development and obtain the financing, partners, customers and regulatory approval for the American Centrifuge. While it has already provided USEC with leases and other "soft" forms of assistance, the U.S. government is not likely to offer outright financial help unless USEC fails to secure funding from the private markets.

### **Signs of a renewed government interest in nuclear?**

Over the last year or so, there have been some signs of a renewed government interest in nuclear power in the US, although primarily at the macro level. Last year's favorable vote on the Yucca Mountain long-term waste storage project was the first indication of a new attitude in Washington towards nuclear power. Part of this is no doubt due to the Republican control of Congress, where strongly pro-nuclear legislators such as New Mexico Senator Pete Domenici have a powerful presence. And after eight years of Democratic control of the executive branch, with Vice President Gore something of a champion for reflexively antinuclear environmental groups, even a bunch of Texas oilmen is a refreshing change for the nuclear industry.

In addition, since September 11, just about every American understands the strategic importance of reducing our dependence on Middle East oil, and many are beginning to appreciate how nuclear power can help accomplish this. An earlier version of the Senate energy bill provided for government loan guarantees for new reactor development, a definite signal that the Republican leadership supports the nuclear option. It is probably overly generous to characterize this as part of an evolving national energy strategy, one that supports nuclear as an important part of the overall energy mix. It may simply be the expected position for a Republican administration and Congress, and may not even be codified into law. Nevertheless, all of these factors are contributing to a new-found respect for nuclear power in our country. And we cannot neglect to mention the outstanding improvements in plant performance that have been managed by our nuclear utilities over the last decade – clearly evidence that, in this case at least, consolidation of operators, economies of scale and regulatory reform have so far been very good for this industry.

But what about the fuel side? So far there are no signs of future government funding, encouragement or other support for the front end of the fuel cycle. Enrichment may be the exception, and we will come back to that in a moment. But in uranium there is unlikely to be any role played by the US government. Government interest in the US uranium mining sector faded away many years ago. With most of the mined uranium coming from stable trading partners Canada and Australia, it is hard to imagine that anyone in government believes it is a national imperative to have a robust domestic mining industry. As has been the case for the last decade, then, the only US mining operations likely to survive or be developed in the future are those that are economically attractive enough to compete on a level playing field with our neighbours to the north.

The same is probably true for the conversion sector, although here things become a bit more complicated. Thanks to the HEU feed, conversion in North America is still abundant and relatively cheap, at least compared to the supply tightening occurring in Europe as a result of the pending BNFL closure. If for some reason Honeywell and GA decided to close the Metropolis facility, not only would we have a supply shortfall for this often-overlooked yet critical processing step, but there would also be ramifications for the smooth operation of the HEU feed logistics. Most of the natural UF<sub>6</sub> returned to Russia for stockpiling and HEU blending is being shipped from Metropolis.

Unlike USEC's Paducah enrichment plant, Metropolis does not appear to be under such severe financial pressure in a US\$5.00 per kgU market. However, there remains a risk down the road - after all, the Metropolis plant is nearly the same age as Paducah. But so far, it is unlikely that anyone in government is focusing on conversion as something that even bears watching, much less meriting intervention.

### **The government role in a new US enrichment plant**

On the other hand, it is interesting to speculate on the possible involvement of the US government with regard to a new enrichment plant. At present, the official line from the Department of Energy is that they support any new venture for additional SWU capacity in the US, on an equal basis. Clearly officials at DOE or the Nuclear Regulatory Commission do not view it as their role to play favourites between LES and USEC, the two entities looking to build new capacity. No doubt LES is concerned whether the NRC will give it a fair shake in comparison to the home team, but at present LES has more significant problems to worry about.

So, given current budgetary constraints and the disinclination toward government involvement in private industry, US policymakers probably see no need to volunteer financial support, instead leaving such decisions to the private sector. This was the whole point in privatising the government enrichment enterprise, after all.

But looking at the two competing projects, it is interesting to examine what might happen down the road. A year ago, many believed that LES held a distinct advantage over USEC in the quest to finance and build a new enrichment plant, due to the proven Urenco technology and partnerships with three of the largest US utilities. At the time, USEC struggled to convince the market that the 20-year-old GCEP technology could be resurrected, and that their difficult financial straits would not be an impediment. The credibility of those assurances were in question, given that much the same had been said about the now-defunct AVLIS technology.

But the last year has witnessed a sharp turnaround in the fortunes of the two projects. LES has encountered severe, potentially fatal problems in its siting efforts in Tennessee, and has lost Cameco as a partner. It is not clear whether it can find a new site in New Mexico and make it through the licensing process, or will again abandon the effort as it did with the first consortium in the 1990s. Meanwhile, USEC has continued to meet or exceed its milestones under its cooperation agreement with DOE, and has plenty of local support in Portsmouth for the new plant. Questions remain about the technology and financing, but clearly the momentum has shifted toward USEC over the past year.

It is important to note that this is not necessarily a winner-take-all sort of race. Indeed, many of the larger US utilities would prefer that both plants be built, giving them two domestic suppliers from which to choose. This is the best as far as a competitive market is concerned, and future demand projections seem to support this outcome (*Figure 2*). However, there may not be sufficient customer or Wall Street support for both plants in the near term. While on one hand USEC

appears to be focused on its own project, as it should be, and not on LES, it has also argued to policymakers that another domestic competitor might have a negative impact on the HEU deal, and therefore on national security. USEC is probably quite concerned about the progress of LES, sensing that there may not be sufficient support for their technology if LES secures a site and financing, and Urenco centrifuges are on the way across the water. As has been their pattern, we expect USEC to act aggressively in the legal, political and public-relations arenas to gain any advantage in this effort.

This brings us back to the US government role. If LES continues to encounter siting problems in the US, Urenco may again decide to pull up stakes and simply expand output in Europe. Urenco has said that this is a viable option on numerous occasions. Even with the benefits of currency hedging and supply-chain logistics that a US facility allows, many have argued that it still doesn't make financial sense in comparison to simply expanding further in Europe and shipping the fuel to the US.

If LES does pull out, and if USEC has trouble obtaining financing, the US government may then have a reason to get involved. The government may perceive that the future of the HEU transaction, US national security, and energy security are at stake. If the private sector sees the USEC project as too risky to fund, the government may be forced to step in with loans, loan guarantees, or other incentives. With the government considering loan guarantees for new reactors, it is logical that it might also consider assistance for a needed enrichment facility.

In 1979, American automaker Chrysler convinced Congress to bail out the company with taxpayer-funded loan guarantees because of harsh economic conditions and the argument that the company's collapse would have done irreparable damage to a large sector of the American economy. In hindsight, we now know, this federal aid was probably no better in the long run than had Chrysler gone through an orderly bankruptcy proceeding. Factories, inventories and other assets would have survived and been reorganised under different ownership and management – just as is the case now with Chrysler owned by Daimler Benz. Fortunately, though, this government intervention was not the beginning of a trend away from American business sovereignty. American taxpayers have not been called upon to bail out other private businesses that could not succeed in the marketplace.

But as noted earlier, USEC is a different sort of animal – a private company with a complicated governmental legacy and ongoing responsibilities on behalf of US national security. Combine this with the fact that USEC operates the last of the first-generation uranium enrichment facilities, and the argument for national security and energy security becomes much stronger. If Paducah's economic life is nearing an end, we would not be surprised to see the government come through with assistance if USEC cannot raise the funding on its own.

Which raises the question - is this a good thing? For the market, the answer is - yes. In order to have a viable fuel infrastructure for the next twenty or thirty years, investments need to be made soon. Cogema recognizes this and is moving

forward with a lower-cost technology. USEC understands what it has to do as well, but may face some problems in getting there. For US utilities to have a competitive enrichment market, some domestic production is desirable, if not essential. If LES does not make it, USEC must, or vice versa.

From a taxpayer perspective, the answer may be more difficult. The government did not have a particularly distinguished record in the management of the SWU plants – just look at the history since the 1970s to see how its actions and policies often distorted the market. And its investments in advanced enrichment technologies did not bear much fruit. But if the government is limited to the role of a behind-the-scenes financial guarantor, it can be argued that supporting an industry that has massive barriers to entry and technical hurdles to ensure some new capacity is built is a good long-term investment. It eliminates a total dependence on Russian HEU, preserves a domestic alternative for buyers, and contributes to the overall energy security of the country. We shall see if this sort of support is necessary, and if it is forthcoming in the next few years.

### **Summary and conclusion**

In conclusion, the US government's policy toward nuclear fuel has changed radically over the years. It has shifted from production and building up the fuel infrastructure to facilitating the consumption of former weapons material. This evolution has closely followed the government's military imperatives. Currently, from the standpoint of the commercial industry, the government is much more focused on the back end of the cycle (e.g. Yucca Mountain), than the front end, despite the fact that US nuclear fuel needs are now greater than ever and the current administration has expressed interest in reviving the nuclear power option.

In light of the American predilection of trying to keep the government out of private industry, it is doubtful that the US government will try to spur new investments in nuclear fuel infrastructure. Hopefully, we can look to the government for stronger support for nuclear power in general, and in encouraging utilities to place new reactor orders. But on the fuel side, we believe that ultimately it is still up to the industry itself, the buyers and suppliers, to ensure adequate new investments are made in infrastructure, so that the availability of fuel or services is not a factor limiting future growth. Especially for the buyers, this may require doing some things differently than in the past to encourage suppliers to take new risks. American utilities in particular have gotten used to taking producers for granted over the last fifteen years, given the robust secondary market supplies. With the market moving toward being more production dependent, that dynamic will change and utilities will be asked to share in more of the burdens and risks, whether financial or otherwise, to encourage new production sources.

The possible exception to the hands-off approach for government would be in enrichment. If USEC is able to retire or refinance a large portion of its long-term debt, and find interested partners and customers, there may not need to be any role for the government to play. If not, and if LES is not successful, the government will have an important incentive to provide help. Given USEC's skill in dealing in the political arena, we would not bet against USEC getting help from the government to bring the American Centrifuge into operation.

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Figure 1. US government fuel cycle programmes 1945 - present

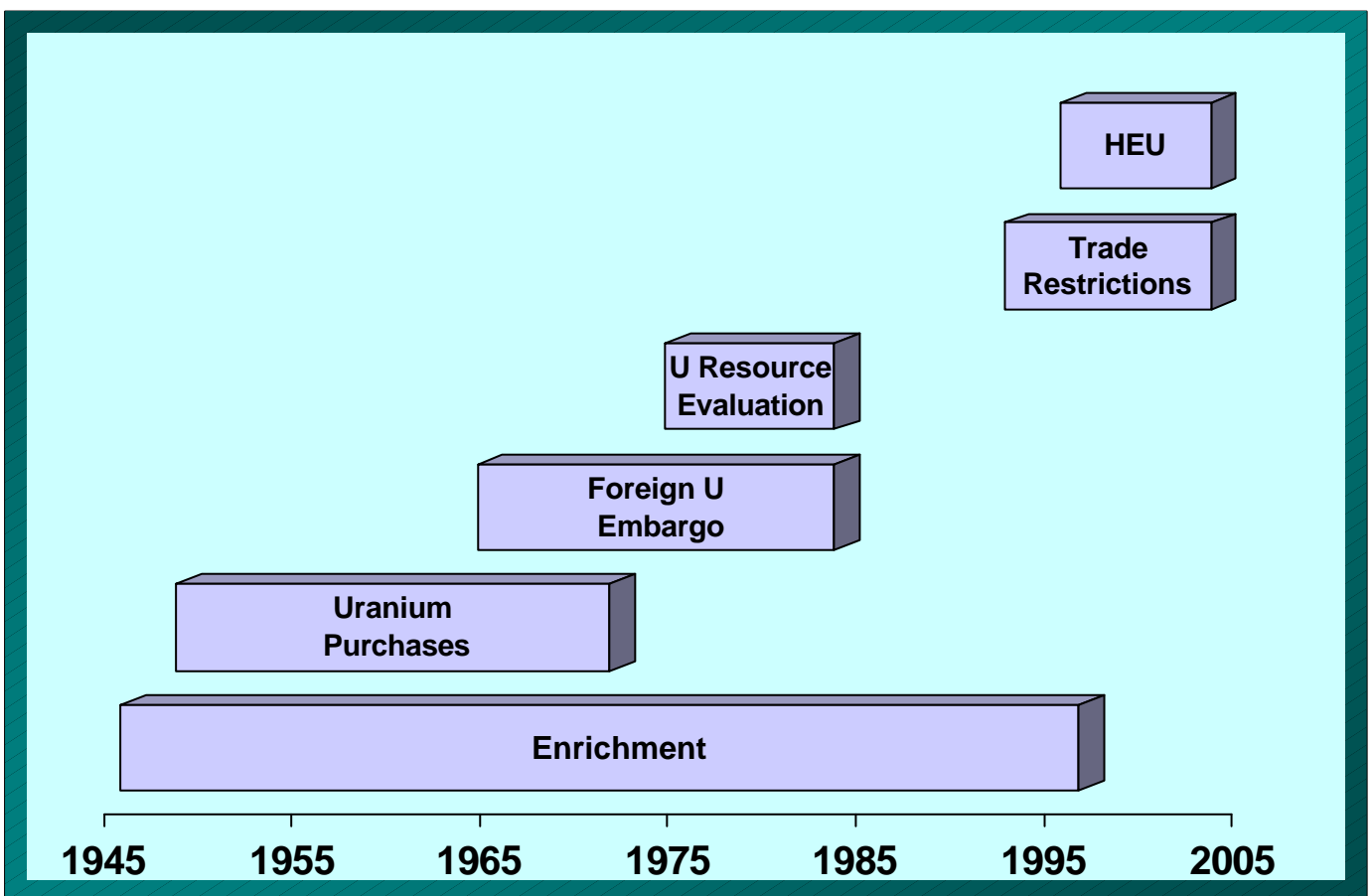
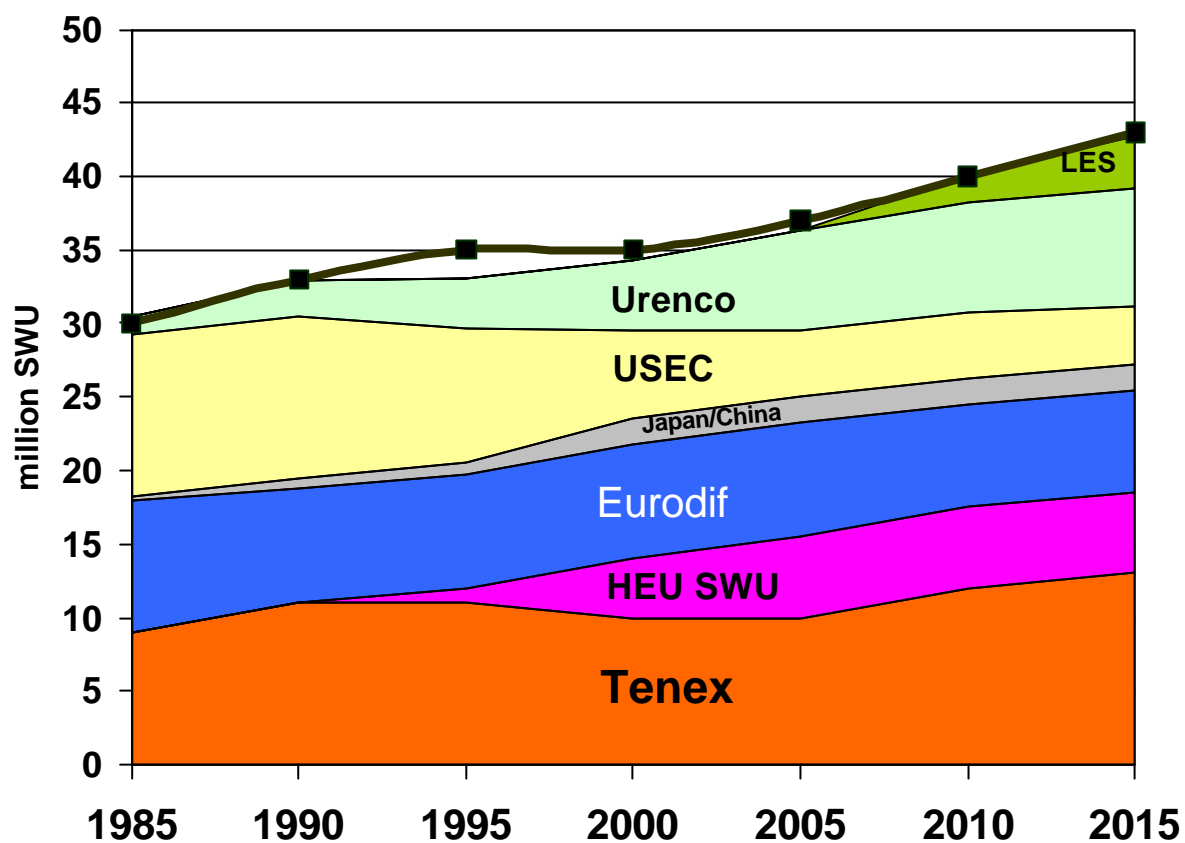


Figure 2. Primary SWU supply vs. demand, 1985-2015  
(economic/marketable production levels)



Future supply scenario based on UxC's production estimates assuming LES and USEC plants are built.