—NON-CONFIDENTIAL VERSION—

Impact of DOE Excess Uranium Sales on the U_3O_8 Market

Prepared for
Fluor-B&W Portsmouth LLC

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Redacted Version

NAC INTERNATIONAL

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Contents

Figures

Tables

1. Introduction

This report provides an analysis of the uranium market and identifies the key factors affecting the market. It also projects future cost trends and the impact certain events could have on these cost trends and prices, including the impact of DOE excess uranium inventory sales. The approach initially taken was meant to closely approximate that taken by Energy Resources International, Inc. (ERI) as described in their report titled "Quantification of the Potential Impact on Commercial Markets of Introduction of DOE Excess Uranium Inventory in Various Forms and Quantities during Calendar Years 2012 through 2033", dated April 23, 2012. NAC then redid the analysis based on what we believe to be a more appropriate approach. ERI performed its analysis based on total supply and demand. NAC believes that in a market with excess production and one where higher cost producers have sold their output and can continue to operate at the expense of lower cost producers, the best approach would be to take into consideration contract commitments. Consequently we have also performed the analysis based on uncommitted supply and demand.

The information used to perform this work was largely obtained from NAC's proprietary data bases: Fuel-Trac and Uranium Supply Analysis System (USA). Fuel-Trac is a model of the nuclear fuel cycle. It estimates uranium demand for each reactor in the world based on the plant operating plan. For reactor operators Fuel-Trac also follows purchases, sales and inventory and calculates uncommitted demand. For suppliers it estimates production, sales and uncommitted supply. The USA system estimates the cost of production for almost 450 uranium properties in the world. This cost information is a key input to forecasting prices. For a more complete description of these data bases please see Appendices C and D.

2. Executive Summary

Uranium market prices are down significantly from the short lived peak that occurred during 2007. Even though the bubble burst very quickly and spot prices corrected to about $43 per pound by the third quarter of 2009, production began expanding almost immediately and is still increasing today. Production increased more than 50% from 2006 through 2013 and NAC projects it will continue to increase in 2014. Most of this increase occurred in Kazakhstan where production has increased by over 425 percent. In addition, there are three large projects outside Kazakhstan that were under construction at the end of 2013. These properties will further increase production (by almost 30 percent) in the next 3 to 4 years.

Unfortunately for the supply industry, outside of China the nuclear renaissance failed to materialize and the Fukushima accident occurred in March 2011. The lower than previously expected growth in nuclear power only affected the need for uranium in the long-term. However, Fukushima immediately reduced uranium demand by about 15 percent per year. Fukushima also reduced demand for enrichment services, leaving enrichers with excess capacity in their capital intensive plants. Low incremental production costs and technical considerations incentivized the enrichers to separate more of U^{235} isotope out of the natural uranium (underfeed), effectively providing another increase in uranium supply. For Russia increased underfeeding partially offset the loss of supply from the weapons down blending program that ended in 2013.

By buying far more uranium than it will need for many years into the future, China is absorbing a sizeable portion of the market's excess supply and propping up current prices. Their purchases have protected producers by mitigating price reductions and inhibiting the needed corrections in production. However, the relative size of the inventory China is building is much larger than any other buyer maintains. As China becomes more comfortable with the workings of the market, NAC expects their procurements to more closely follow other buyer strategies. If this occurs China will not need to enter into contracts for significant new purchases for more than a decade. On the other hand, if China continues to add to an already massive inventory, the market should be concerned about the motivation to amass such large quantities of uranium and the market power it provides.

The current market situation will not last forever and eventually prices must increase to encourage the supply expansion needed in the future. However for prices to increase or even stabilize in the next few years, additional production must be closed and/or deferred. Without these adjustments, NAC believes prices will not increase significantly before [redacted]. Suppliers have been reluctant to make the required adjustments for a number of reasons including a belief that prices would increase in the near-term. The current analysis suggests that assumption is wrong. If this proves correct, there will be increased incentive to make the hard decisions to reduce production in the next year or two. Of course, suppliers would like to see secondary market sources eliminated instead of production. However, more than [redacted] percent of the secondary market supply is projected to come from under feeding Russian enrichment plants and from recycling materials recovered from reprocessing spent fuel. Except for the relatively small amount of projected URENCO under feeding, none of this supply is expected to be removed from the market except through sales. One way or the other it will be sold and it will overhang the market until then.

There are an abundance of properties with incremental costs in the [redacted] per pound range that could produce throughout the next decade if the uranium needed. Consequently NAC would not normally expect prices to approach the levels seen during the last price spike. However, the industry has a tendency to act in unison. Therefore there may be periods when prices rise to abnormally high levels before falling well below that needed to sustain production at required levels. The longer prices remain low, the more likely such a reaction will occur.

The quantities forecasted to be sold by DOE through the barter and other programs are small, have not had nor are predicted to have in the future a material impact on uranium prices. Clearly market prices are lower than those attained during the 2007 bubble but they are 3.5 to 5 times the levels of the decade before the start of the run up in 2004. Producers that decided to not lock in the high prices (through term contracts) and gambled on prices continuing to rise further, made a mistake. Those producers are now paying for their exuberance.

NAC used its models to estimate the impact of the DOE sales on future uranium cost trends (the incremental cost of the marginal supplier needed to satisfy demand in any given year). [redacted]

[redacted] This analysis was based on total supply and total demand, assuming production is built up starting with the lowest cost producer and sequentially adding higher cost producers until demand is met.

NAC does not believe that this methodology is a good representation of the manner in which the industry operates. Most uranium is sold under term contracts with deliveries made over 3 to 10 years into the future and executed several years in advance of the first delivery. Consequently some higher cost producers that had the foresight to lock in higher prices may be able to produce in lieu of lower cost producers. Therefore NAC believes the better methodology is to estimate the impact based on uncommitted demand and uncommitted supply. We believe this is the way that prices are determined by the market. [redacted].

NAC's market-balancing model derives an annual cost trend based on the last increment of uncommitted supply needed in a given year to meet projected uncommitted demand. This cost trend, however, does not include all of the costs for a particular producer. The costs reflect NAC's opinion of *site forward* production costs only, not an estimate of all costs experienced by a producer. To account for these factors, NAC believes it is appropriate to apply a multiplier of between [redacted].

The range for the assumed multiplier is comprised of two assumed components:

[redacted]

In addition, producers need to have a price signal in order to begin investing in new production centers. In other words, they need to see prices which justify the investment before actually making the investment. However all of the properties needed in the 2014 through 2021 period are already operating or under construction. This suggests the cost trend values for 2014 and 2018 should provide the basis for a price forecast in these two years without the impact of a time shift.

With these assumptions and the upper end of the range for the multiplier, NAC estimates [redacted].

3. U_3O_8 Market

3.1 Setting the Stage

In 2013 uranium prices continued the downward trend from the inflated prices reached in 2007. Prices have fallen because the very high prices over-stimulated supply during a period when near-term demand fell. In addition, the high prices created a concern over future availability which encouraged a very high level of contracting in the 2005 through 2012 period. This contracting reduced future uncommitted demand substantially. Consequently buyers have very little need to make new purchases and contracting activity fell to record low levels in 2013.

Near-term demand is being adversely impacted by:

- Continued delays in anticipated Japanese reactor restarts, now three years after the Fukushima accident
- Premature reactor shutdowns in the U.S. and Germany
- Temporary reactor shutdowns in South Korea

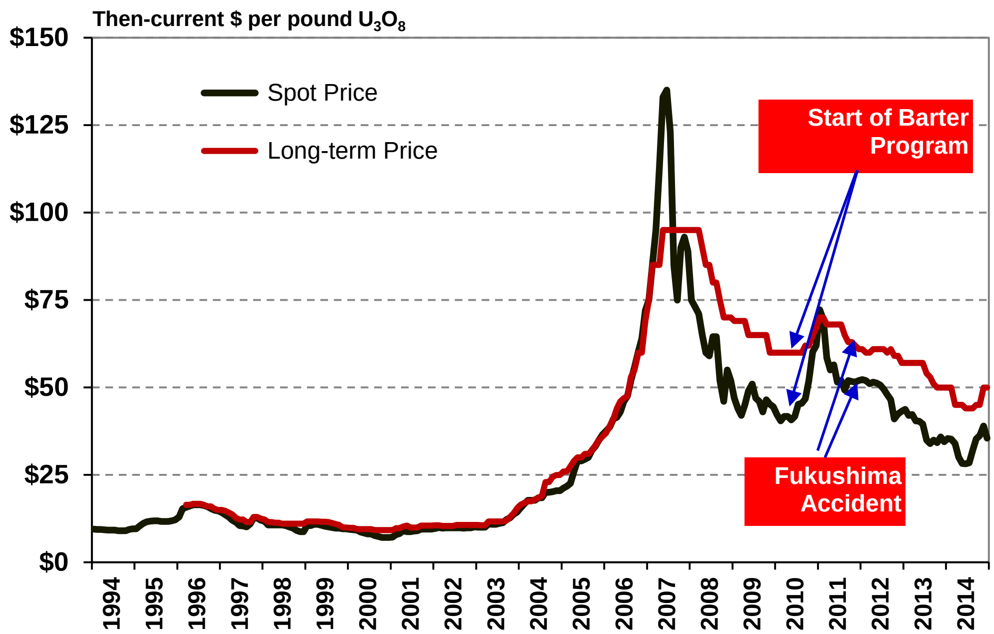
Despite lower demand and some announced supply cutbacks and deferrals, primary production increased slightly last year. Even with these supply cutbacks; some growth in nuclear generation (principally in Asia); and significant extraordinary purchases for inventory (principally by China), there is excess supply and further cutbacks are needed to stabilize prices.

Figure 3.1 shows average spot and long-term price indicators since 1994. The figure shows spot and term prices were around $10 to $15 per pound from 1994 until early 2004. Spot prices then began a steep climb, reaching $135 in 2007 for a brief period. Prices then began to fall, bottoming in early 2010 at about $41(just after the start of barter sales began). However later in 2010, prices rebounded quickly, reaching over $72 just before the Fukushima accident. Since Fukushima, spot prices have fallen steadily to the current $32.50 per pound.

Until 2007 there was little difference in reported term and spot prices. At the market peak term prices were lower than spot prices but have shown a significant premium ever since. The average long-term premium for the first quarter of 2014 was of 39 percent. Since NAC estimates that worldwide unfilled utility demand in 2014 is only [redacted] of reactor requirements, upward near-term pressure on spot prices is unlikely.

Absent additional retrenchment by primary producers, NAC believes both spot and term indicators will weaken further in the coming months. For prices to stabilize and eventually strengthen in response to anticipated longer-term demand growth, primary U_3O_8 producers must make further cutbacks and deferrals to more closely balance the near-term market.

Figure 3.1 Average Annual U_3O_8 Spot and Long-Term Price Indicators vs. Long-Term Price Indicator Premium (Then-current $/lb. U_3O_8)



Source: Average annual price indicators (averages of month-end values)—TradeTech

The key items currently impacting the market are:

- China's continued nuclear generation growth and inventory accumulation
- Lack of any significant near-term uncommitted demand
- Higher value of the dollar compared to the devalued major producing country currencies
- Cut backs in demand due to shutdowns, deferrals and Fukushima
- Excess near-term production, particularly in Kazakh
- Continued development of large new production centers including: Cigar Lake, Husab and Imouraren
- Underfeeding of enrichment plants

3.2 Issues Affecting the Market

3.2.1 Chinese Presence and Potential Influence on the U3O8 Market

3.2.1.1 Chinese Uranium Procurement

Based on NAC's forecast of nuclear generation growth and Chines inventory and future purchases, China continues to buy much more uranium than it can reasonable expect to use for more than a decade into the future. With its existing commitments and prior purchases, China would not ***need*** to purchase any additional U_3O_8 until [redacted] to meet its reactor requirements. In order to maintain a strategic inventory, new purchases would need to be somewhat earlier [redacted].

NAC estimates that China's total inventory of U_3O_8 equivalent (in all forms) at the end of 2013 was around [redacted] pounds. This estimate is about eight times higher than estimated 2014 reactor requirements.

China reportedly imported a total of approximately [redacted] pounds U_3O_8 in 2008-2013, which NAC assumes reflects U_3O_8 equivalent in all forms. The Fuel-Trac® database shows cumulative reactor requirements in 2008-2013 of about 48 million pounds. This suggests an end-of-year 2013 inventory of *at least* [redacted] pounds U_3O_8 equivalent.

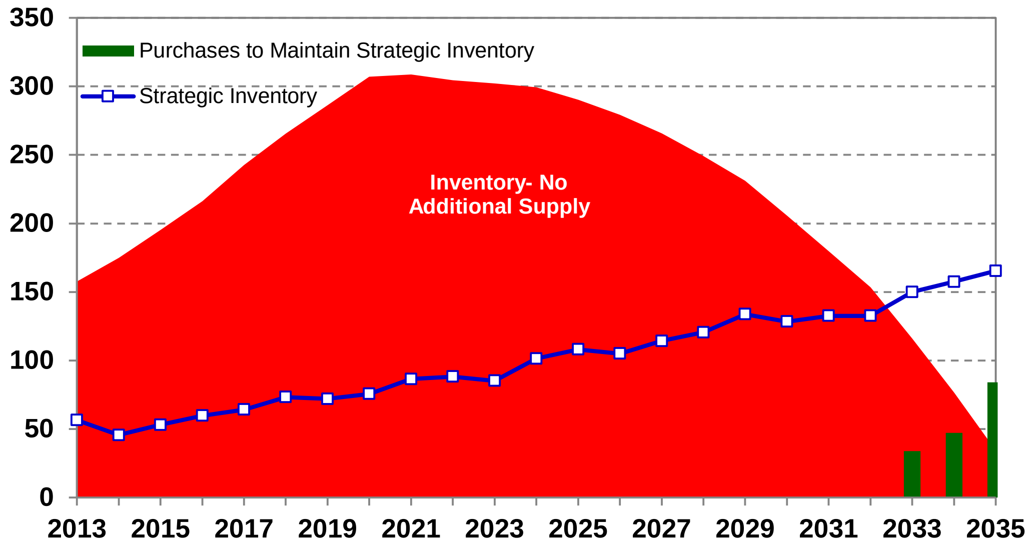
China was importing U_3O_8 concentrates from several producers prior to 2008. This material, combined with domestic Chinese U_3O_8 production, implies that China probably had a significant inventory of U_3O_8 concentrates at the end of 2007. In this context, NAC's estimate of [redacted] pounds of U_3O_8 equivalent inventory at the end of 2013 may in fact be low.

As China gains more experience in the commercial markets, we believe its comfort level with the markets ability to provide adequate supplies will increase and its desired strategic inventory will approach norms exhibited by other Asian buyers. As such, we believe the longer-term desired inventory level for China will be lower at around [redacted] of forward requirements.

Figure 3.2 projects the evolution of U_3O_8 equivalent inventory for China assuming preservation of a minimum strategic inventory equivalent to three years of forward reactor requirements. With no additional purchases and no sales, China's end-of-year inventory is projected to peak at about 310 million pounds U_3O_8 in 2020, about 10.6

times higher than estimated 2021 reactor requirements and almost twice 2013 world production. As existing delivery commitments decline in 2020 and beyond, while reactor requirements continue to increase, the inventory is projected to rapidly decrease. However, even if they maintain a minimum three-year strategic inventory, additional purchases would not be needed until 2033.

Figure 3.2 China Inventory and Purchases Required to Maintain a Three-Year Strategic Inventory (Millions of Pounds U_3O_8)



With the projected build-up of a very large Chinese inventory of uranium over the next seven years, China will be in a position of great market strength, sufficient that its actions alone could influence the direction of the market. This market power will be a concern for producers and buyers alike, not least because the overall motivations and specific goals of China with respect to uranium supply are not well understood.

China is expected to act rationally which, put another way, would mean that it would be expected to act in its own interest within the constraints and pressures of the economic system in which it must operate. In the past China has made some large purchases of uranium, perhaps motivated in part by an optimistic view of worldwide demand growth at the time and a related desire to comfortably secure needed uranium supplies. Today such forecasts of demand growth would be difficult to support and continuing its market price support seems unlikely.

The large Chinese inventory position would allow them to:

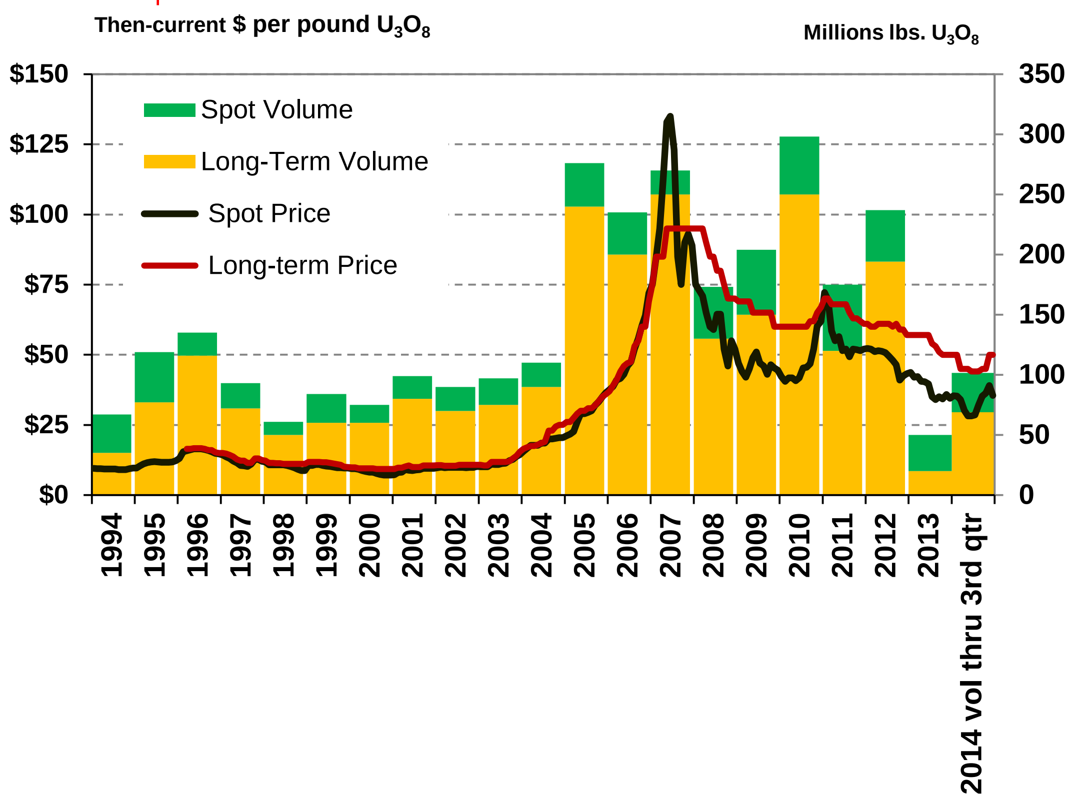
- Defer any new purchases for a long time into the future (potentially for as long as [redacted]);
- Sell some of the uranium that is in excess of their desired minimum strategic inventory at any given time;

The extent of market power concentrated in China would mean that their actions could have a large impact on prices.

3.2.2 Lack of Near-Term Demand

With the loss of about [redacted] pounds per year of demand due to the Fukushima accident and the vast majority of near-term utility needs already covered, buyers have little concern over the possibility of higher prices for the foreseeable future. Consequently term contracting activity virtually disappeared last year. Term contract volume in 2013 was only 20 million pounds U_3O_8, the lowest level reported in the last 20 years. As shown in Figure 3.3, term market volume in 2013 was even lower than spot market volume.

Figure 3.3 Worldwide Spot and Term Purchases



3.2.3 Currency Exchange Rates

Australia, Canada, Kazakhstan and Namibia combined accounted for 71 percent of estimated world U_3O_8 production in 2013. (See Appendix B, Figure B.2.) During 2013, the U.S. dollar strengthened significantly against the currencies in three of these countries:

- 16.3 percent against the Australian dollar
- 6.9 percent against the Canadian dollar
- 23.5 percent against the Namibian dollar

During 2013, the U.S. dollar strengthened by only 2.6 percent against the Kazakh tenge. On February 11, 2014, however, Kazakhstan announced a 19 percent devaluation of the tenge. As a result, between the beginning of 2013 and February 25, 2014, the U.S. dollar strengthened by 23.1 percent against the Kazakh tenge.

In general, a strengthening of the U.S. dollar against a given country's currency tends to result in lower effective production costs for that country in U.S. dollar terms. The extent to which a stronger U.S. dollar results in lower effective production costs depends on how much of the exchange rate benefit is offset by inflation within the country and the proportion of costs in the domestic currency versus foreign currencies (if any). Depending on inflation, a strengthening of the U.S. dollar generally tends to exert some downward pressure on spot prices denominated in U.S. dollars.

In general, the 2013 version of NAC's Uranium Supply Analysis System (USAS) provided the basis for the production cost estimates used in this report. (See Appendix C for a summary description of the USAS). However, we made ***downward*** adjustments to the cost estimates in the 2013 USAS for all properties in Australia, Canada, Kazakhstan and Namibia. We did so in an attempt to account for the impact of the strengthening of the U.S. dollar against the currencies in these four countries since the beginning of 2013, taking into account the offsetting effect of estimated inflation and, for Namibia, the proportion of costs in the domestic currency versus foreign currencies. These cost estimate ***decreases*** ranged from about [redacted].

3.2.4 Primary Supply Cutbacks and Deferrals

In response to weaker prices, some U_3O_8 producers began announcing cutbacks and deferrals in September 2013, while others continued to add capacity. [redacted] summarizes the announcements that have been made to date.

The temporary shutdown of [redacted] alone has removed about [redacted] million pounds of capacity from the market. Based on last year's estimated output, the planned approximate one-year shutdown of the [redacted] will remove an additional [redacted] pounds from primary supply. In addition, the [redacted]. The cutbacks and deferrals that have been announced so far, however, have not yet had any noticeable impact on supply/demand balance or prices.

Table 3.1 Primary U_3O_8 Supply Cutbacks and Deferrals Announced Since September 2013

[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]
		[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]
		[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]
		[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]

[redacted]”

3.2.5 Excess Near-Term Production

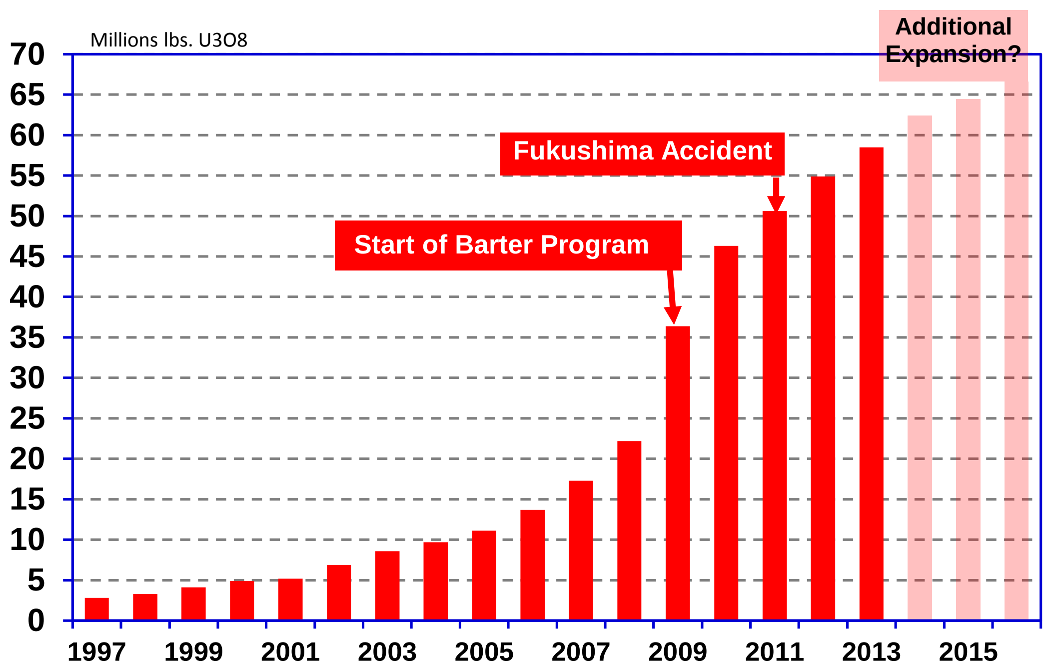
3.2.5.1 Kazakh Production

In the past 10 years Kazakh production has increased from less than 10 million pounds per year to 58.5 million, a 600 percent increase (see Figure 3.4). Increases in the past two years contradicted the announcement made in October 2011 that annual production would stabilize at around 52 million pounds U_3O_8. At the same time, however, Kazakhstan also noted that annual Kazakh output could increase to 65 million pounds if justified by market demand.[1] Total Kazakh output in 2013 was about 6.5 million pounds higher than the 52-million pound target announced in October 2011.

In April 2013, a "strategic plan" submitted to the government indicated that near-term Kazakh production would be:

- 2014: 62.4 million pounds
- 2015: 64.4 million pounds
- 2016: 66.6 million pounds[2]

Figure 3.4 Kazakh U_3O_8 Production



Kazatomprom's November 2013 announcement that uranium output expansion was being suspended may suggest that Kazatomprom has realized that its actions are an important influence on price. As the largest supplier it stands the most to gain from any price increase. However, notwithstanding its public statements, it is not clear that Kazatomprom will reduce production. The statements have been interpreted by some to mean, existing sites can expand but no new mines will be developed.

1. Embassy of the Republic of Kazakhstan, 2011 News Bulletin No. 38, 10/25/11.
2. 4/15/13 *Central Asia Economy* Newswire article (www.universalnewswires.com/centralasia/economy/viewstory.aspx?id=13973)

3.2.5.2 Continued Development of Large New Production Centers

Despite the big reduction in market prices from the 2007 price spike, there are several large production centers outside Kazakhstan that have just started production or planned to start operating in the next few years. Cigar Lake began operating in 2014 and will have an ultimate capacity of 18 million pound per year. Husab is being actively developed and is planned to begin operations in 2016 with a capacity of 14.2 million pounds per year. Imouraren is planned to start operating in 2017 and eventually reach a capacity of 13 million pounds per year. These 3 properties could increase world production by almost 30%.

3.2.6 Underfeeding Enrichment Plants

The Russian enrichment plants have had substantial excess capacity for many years. Yet Russia continues to expand its capacity. This excess capacity is then used to underfeed its plants. Other enrichers were impacted by Fukushima. The loss of the Japanese and German reactors reduced enrichment demand in the very near-term leaving no alternative markets available. Centrifuge enrichment plants are capital intensive and have low operating costs. There are also technical reasons to not start up and shutdown centrifuges. Faced with this situation, Rosatom and URENCO have chosen to underfeed their plants and “produce” uranium. This uranium is being sold into the market, increasing uranium supply.

3.3 Outlook for Future Primary Production Capability

Figure 3.5 shows estimated world primary U_3O_8 *supply capability* by increments of *forward cost with a ROR only* for properties that are *operating and under development*. In general, these projections reflect an assumed *85 percent of technically attainable capacity*. The following overriding property-specific assumptions, however, for some key properties are reflected in Figure 3.5:

- Except for Cigar Lake, annual output for all properties in which Cameco has an interest is based on Cameco’s plan for 2014[3]
- Cigar Lake, which is now operating, is assumed to gradually ramp-up output in 2014-2017 with full capacity available starting in 2018
- Ranger is assumed to resume operations at the beginning of 2015

3. Cameco’s 2/10/14 “Management’s discussion and analysis”, p. 57.

- Husab is assumed to startup in 2016
- Imouraren is assumed to startup in 2017 and gradually ramp-up output in 2018-2019 with full capacity available starting in 2020

Figure 3.5 World U_3O_8 Production Capability for Operating/Under Development Properties by Forward Cost in Constant 1/1/14 Dollars (Millions lbs. U_3O_8)

[redacted]

Figure 3.5 reflects the impact of announced cutbacks and deferrals, as summarized in [redacted] (e.g., no supply capability is included for [redacted]). Based on the November 2013 Kazatomprom announcement that expansion of uranium output would be suspended, Figure 3.5 assumes that total Kazakh supply capability in 2014-2019 remains constant at 58.5 million pounds, the same as 2013 production. The significance of this assumption will be discussed later in the context of the initial supply/demand comparison.

3.3.1 2013 Production

Estimated worldwide primary production increased by two percent last year to about 155.8 million pounds U_3O_8, due largely to higher Kazakh production. (See Figure B.1 in Appendix B, which provides summary metrics for the primary U_3O_8 supply industry.) NAC estimates that primary supply capability in 2014 will be about one percent higher than 2013 production.

3.3.2 Operating Properties

Operating properties with estimated *site forward* costs (including a ROR) of under [redacted] per pound make up the largest portion [redacted] of operating and under development supply capability in 2014-2030. The supply capability for all operating properties included in Figure 3.5 decreases by [redacted] million pounds ([redacted] percent), from a peak of [redacted] million pounds in [redacted] million pounds in [redacted] due to projected depletion of reserves. Approximately [redacted].

The combined capability of the [redacted] largest operating properties account for [redacted] percent of the total in 2014:

[redacted]

- [redacted]

Reserves are projected to be depleted by 2030 for [redacted]. The other four properties are estimated to have sufficient reserves to sustain output through 2030.

3.3.3 Properties under Development

NAC currently considers ten properties to be under development[4]. The two largest such properties account for 76 percent of the cumulative supply capability through 2030:

- Imouraren (Niger):
  - Site forward cost including ROR: [redacted] per pound
  - Currently anticipated startup: late 2015 or early 2016 but AREVA recently indicated that the project could be delayed and/or ramp up could be slower than previously imagined
- Husab (Namibia)
  - Site forward cost including ROR: less than [redacted] per pound
  - Currently anticipated startup: Initial production expected by the end of 2015 or in early 2016

The other seven under-development properties included in Figure 3.4 are:

4. As defined in NAC's Fuel-Trac database (i.e., properties for which ground breaking has begun).

[redacted]

3.4 Secondary Supply

3.4.1 Utility Inventories

NAC estimates that total worldwide utility inventories (as U_3O_8, natural UF_6, enriched UF_6 and fabricated fuel assemblies) at the end of 2013 were approximately [redacted] pounds U_3O_8 equivalent[6]:

- [redacted] million pounds U_3O_8 equivalent as strategic (desired) inventories
- [redacted] million pounds U_3O_8 equivalent as non-strategic (excess) inventories
- These projected total and excess inventories represented approximately [redacted] years and [redacted] years, respectively, of world reactor requirements in 2014.
- To date, it appears that most Japanese utilities ([redacted]) have not sold excess inventories associated with Fukushima. Some material from excess Japanese inventories, however, may eventually find its way into the market. The longer that reactors remain shut down, the more likely that some inventory sales will occur.
- Selling material now, however, would mean the utilities would take substantial losses relative to the prices paid for the material. In addition, utilities can to some extent include uranium carrying costs in their rate bases at a rate higher than the loan rate today. Thus, there are some motivations for the utilities just to hold the material until it is needed.

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5. Captive production is defined as material expected to be used only for domestic needs.
6. NAC October 2013 *U_3O_8 Status Report*

3.4.2 Inventories of Suppliers/Intermediaries

NAC believes that most inventories held by U_3O_8 producers and other suppliers (enrichers, fabricators and others) consist of work-in-process material and/or strategic/operational inventories. As such, NAC assumes that none of this material is available on the open market. However in 2013 uranium producers produced more uranium they sold and producer inventories increased by [redacted] million pounds U3O8. About [redacted] of this is anticipated to be delivered to customers in [redacted].

Hedge funds are believed to have more than [redacted] million pounds U_3O_8 equivalent in inventory. Uranium Participation Corporation (the only publicly traded uranium fund) alone accounts for about [redacted] million pounds U_3O_8 equivalent, or almost [redacted] of the total. Eventually much of this material may come back into the market. If market re-entry of the material occurs gradually, the potential downward pressure on prices would tend to be diminished.

3.4.3 Other Sources of Secondary Supply

The major source of other secondary supply is the availability of natural uranium from the underfeeding of Russian enrichment plants (as discussed in Section 2.2.)

Appendix A provides an overview of additional secondary supplies that are currently available, or might be made available, from the following sources:

- Underfeeding of URENCO's enrichment plants
- Reprocessed uranium (RepU)
- U.S. Department of Energy (DOE) inventories

Estimates of U_3O_8 equivalent quantities assumed to be available from worldwide secondary supply sources in 2014-2030 are summarized in Table 3.2. *Russian underfeeding is the largest source of secondary supply* [redacted].

Table 3.2 Assumed Availability of Worldwide Secondary Supply—Base Case

Source	Approximate Quantity (Millions lbs. U_3O_8 Equivalent)	Years Assumed to be Available	Average Per Year (Millions lbs. U_3O_8 Equivalent)
Underfeeding of Russian enrichment plants[a]	[redacted]	[redacted]	[redacted]
Underfeeding of Urenco enrichment plants	[redacted]	[redacted]	[redacted]
RepU	[redacted]	[redacted]	[redacted]

Planned DOE excess uranium inventory sales:[b]	[redacted]	[redacted]	[redacted]

a. [redacted].

b. See Table A.2 for details.

3.5 Initial Supply/Demand Comparisons

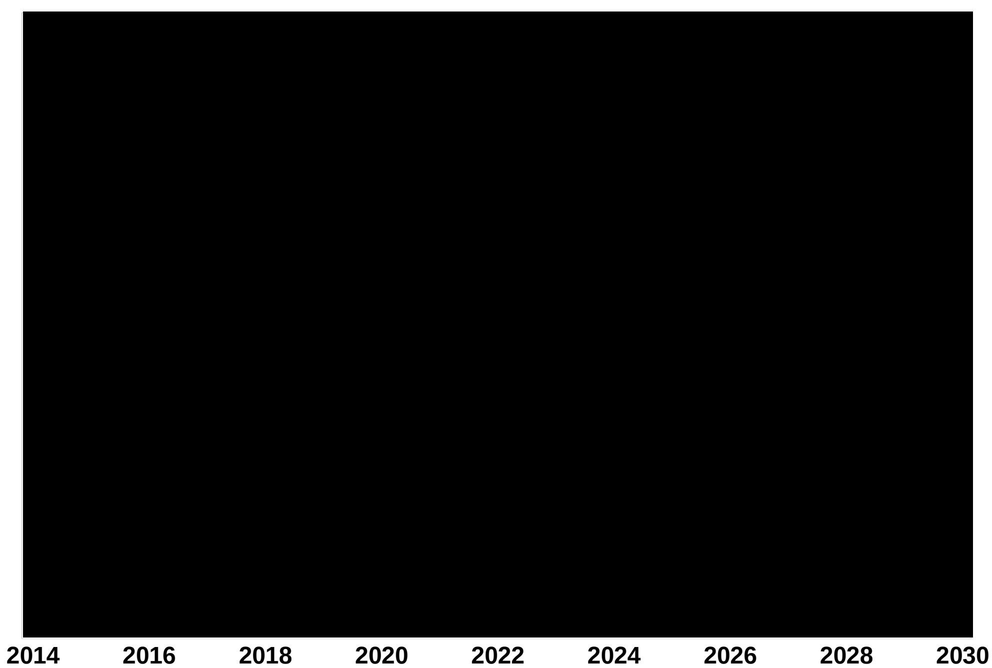
3.5.1 Baseline Demand

Figure 3.6 compares *total Baseline worldwide demand* with estimated secondary supply (per [redacted]) plus projected primary production capability based only on properties that are currently operating (per Figure 3.5). Total demand consists of two components:

- Baseline reactor requirements
- Additional uranium purchases by China

NAC believes the current U_3O_8 market demand is significantly higher than that required to meet reactor requirements due to large quantities of additional uranium being purchased by China. This additional demand is shown in Figure 3.6 and is helping to support uranium prices.

Figure 3.6 Worldwide Baseline Supply/Demand Balance [Millions pounds U_3O_8]



Secondary supply plus production from operating properties is projected to be adequate to meet total Baseline demand (including the extra demand from additional Chinese purchases) through [redacted]. Relatively small supply gaps would exist in [redacted]. In [redacted] and beyond, however, the annual supply gaps that would have to be met by additional primary production increase dramatically.

As previously stated, the projected Kazakh production included in Figure 3.6 for 2014-2019 is assumed to be the same as 2013 production (58.5 million pounds). This assumption is in keeping with the November 2013 announcement that expansion of Kazakh output would be suspended. Figure 3.7 compares projected Kazakh supply capability for operating properties (per Figure 3.6) with the strategic plan for 2014-2016 announced in April 2013. Given the recent track record of increased annual production, there is no guarantee that the Kazakhs will hold output constant in the near-term. If Kazakhstan were to meet the April 2013 strategic plan, excess world supply in 2014-2016 would increase by about [redacted] pounds. After 2019 Kazakh production begins a rapid decline as the identified reserves for these operating properties are exhausted. Kazatomprom is a government-owned company and the government plays a significant role in operating decisions. Kazatomprom has the rights to about 55 percent to 60 percent of production but it controls 100%. Thus the government could decide to maintain higher production levels even if project economics are not justified. Depending on the magnitude of additional production, this could have a significant impact on market prices.

Two factors could prevent the decline in projected Kazakh production capability after 2019 from being as large as depicted:

- Delineation of new reserves at properties currently in operation, thereby extending their operating lives
- Bringing new properties into production

NAC believes the second factor would have a limited impact based on known properties. NAC's 2013 USA System data base contains [redacted] properties other than the ones that are currently operating, representing a total annual capacity of [redacted] million pounds. Only three of those have estimated site forward costs with ROR of [redacted] per pound, and their combined annual capacity is only [redacted] million pounds.

It is difficult to speculate on the Kazakhs' ability to increase reserves/resources at existing mining sites. In addition, it is possible other properties might exist that the Kazakhs have yet to fully disclose.

NAC believes Kazakhstan's ability to prevent its future longer term production from decreasing substantially will depend largely on its success in finding new reserves at its existing operations. To the extent that additional exploration and development activities are successful at existing sites, Kazakhstan may be able to sustain long-term production at higher levels than shown in Figure 3.6.

Figure 3.8 compares the supply gap reflected in Figure 3.6 based on operating properties only with supply capability associated with under development properties. The fact that the projected supply gap does not begin [redacted] suggests that additional supply from any under development properties is not ***needed*** before then. In reality, some under development properties, most notably Husab, will likely begin operation [redacted], thus accentuating a potential oversupply situation for the remainder of this decade. In light of apparent long-term security of supply concerns, the Chinese seem determined to move forward with the project to help meet the uranium requirements of their aggressive domestic nuclear power program. The official strategy is to obtain one third of needs from each of domestic production, foreign contracts and foreign properties where China has an equity interest. Domestic production does not appear capable of meeting its planned share. As a result the other two must increase their contribution.

Figure 3.7 Comparison of Kazakh Production Capability Scenarios [Millions pounds U_3O_8]

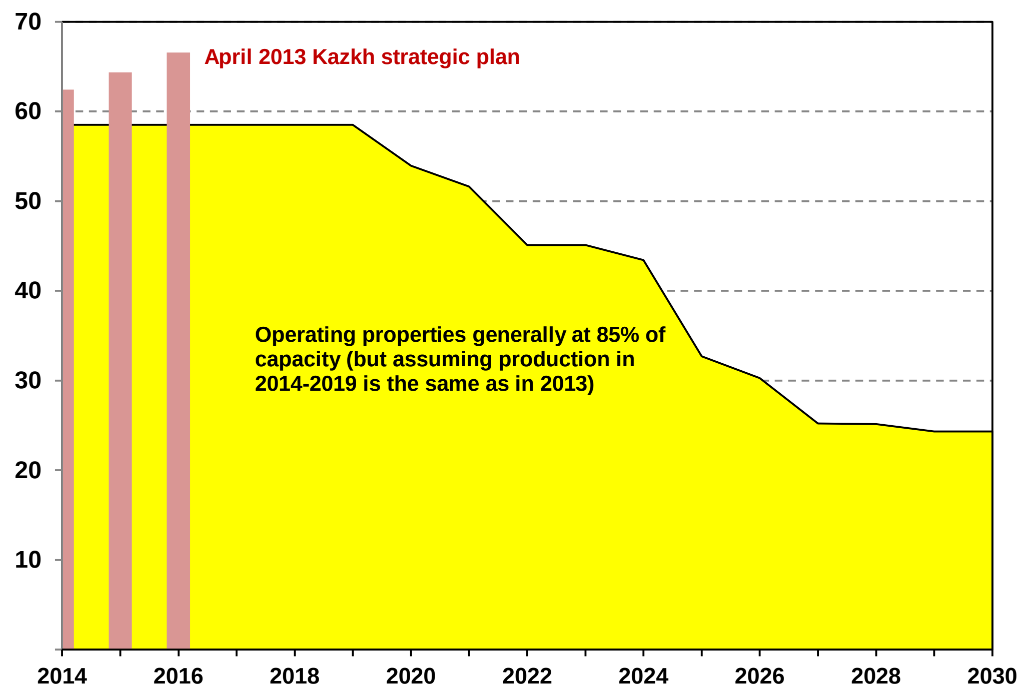


Figure 3.8 Comparison of Baseline Supply Gap and Potential Supply from Properties Under Development [Millions pounds U_3O_8]

[redacted]

2014 2016 2018 2020 2022 2024 2026 2028 2030

A key takeaway from Figure 3.8 is that these properties are not needed on their planned schedules. Although several seem committed to their announced schedule, others, particularly, Imouraren may well be delayed beyond NAC's assumed 2017 startup date used for the initial supply/demand comparison.

Given the intermediate over-supply situation suggested by Figure 3.8, and the fact that Husab is expected to startup regardless, some additional retrenchment of primary supply capability will be necessary to bring the market into balance.

3.6 Cost Trends

3.6.1 Based on Total Supply versus Total Demand

Based on competitive market theory, the price for a market in equilibrium is equal to the incremental cost of the last supplier needed to meet demand. Figure 3.9 presents the "cost trend" resulting from a total supply-demand analysis. The Baseline cost trend was developed by balancing total supply and *total demand* (reactor requirements *plus* estimated additional purchases by China), generally assuming output at 85 percent of technically attainable primary capacity.[7] This balancing was achieved by using a "bottom-up" approach in which annual primary supply capability was added each year, beginning with the lowest cost property, until total supply was equal to total demand in a given year. Estimated *site forward* cost including ROR was used as the basis for deriving the total supply/demand cost trend since it was assumed that higher cost properties would shut down if they could not at least cover their site forward (marginal) costs.

Figure 3.9 Worldwide Baseline Cost Trend Based on Balancing Total Supply and Demand – Estimated Site Forward Cost Including ROR (Estimated Constant 1/1/2014 $/lb)

[redacted]

All properties in the 2013 USAS were included in the market balancing algorithm used to derive the cost trend in Figure 3.9. The algorithm used to derive the cost trend ignores the contractual commitment situation and developmental status[8] of properties. This approach assumes perfect knowledge by producers, i.e. that they will invest in anticipation of prices that will justify their investment. In the real world, the current or near-term price tends to influence investments. Nonetheless, the cost trend provides a sound basis for

7. The market balancing routine assumed no ceiling on Kazakh production other than the economic constraint of the competitiveness of Kazakh properties (based on estimated *site forward* cost including ROR) with other properties.
8. Except that default lead times are assumed based on a property's current status to derive assumed technically achievable startup dates.

drawing conclusions about longer-term U_3O_8 spot prices. Assuming perfect knowledge of future prices, Figure 3.9 demonstrates *there is sufficient supply at estimated constant-dollar **site forward** costs* [redacted] *per pound to meet Baseline reactor requirements plus estimated additional purchases by China through* [redacted].

3.6.2 Based on Approximation of Uncommitted Supply Versus Uncommitted Demand

In an ideal circumstance with perfect information available, a market balancing exercise to determine the cost for the last supplier needed should compare uncommitted demand with uncommitted supply. In a market with growing demand and available supply less than future demand, a calculation based on total supply versus total demand should be adequate. However, when current and expected supply is greater than future demand, the calculation really needs to be done based on uncommitted supply versus uncommitted demand.

The estimation of year-by-year uncommitted supply and uncommitted demand into the future is subject to considerable uncertainty because the names of the buyers and sellers in individual contracts and specifics regarding quantities and delivery years are not disclosed as a matter of routine. That said, NAC invests a lot of effort to discover a large amount of this type of data and bring it all together in the Fuel-Trac database model of the nuclear fuel cycle. This has been used as the starting point for developing a U_3O_8 spot price forecast based on uncommitted supply and demand instead of total supply and demand.

The methodology used to derive estimated uncommitted *primary* supply was as follows:

- For each producer in our database, estimated production capability was derived by assuming output at 85 percent of nominal capacity
- Existing delivery commitments for each producer were subtracted from estimated production capability to determine an estimate of uncommitted supply
- For companies with ownership interests in multiple properties, commitments were allocated to the lowest cost property first

The following assumptions were used regarding uncommitted supply associated with our estimates of available *secondary* supply sources:

- UF_6 from underfeeding of URENCO enrichment plants was assumed to be on average [redacted]

[redacted] UF_6 from underfeeding of Russian enrichment plants was assumed to be [redacted]

- Reprocessed uranium was assumed to be:

  [redacted]

- Excess DOE inventory was assumed to be:

  [redacted]

The estimate of uncommitted demand consisted of two components:

- Worldwide utility uncommitted demand, based on estimates in our Fuel-Trac database
- Supplier delivery commitments in excess of estimated production capability (which suggests that suppliers would have to buy this material on the spot or term market)

The available uncommitted primary supply, on a basis of individual properties, was ranked according to estimated forward cost including a ROR. Estimated uncommitted secondary supply was assumed to be available at a cost just below the lowest cost primary supply property. Using these data, an *initial* balance of estimated uncommitted supply and demand was made, to develop a year-by-year cost trend based on the "sub marginal" property (i.e., the next highest cost property with uncommitted supply after the property needed to meet uncommitted demand in each year).[10]

Figure 3.10 presents the cost trend resulting from an uncommitted supply-demand analysis associated with the Baseline MW projection. Figure 3.10 implies *there is sufficient supply at estimated constant-dollar* ***site forward*** *costs* [redacted] *per pound to meet Baseline reactor requirements plus estimated additional purchases by China through* [redacted].

9. Reflects commitments to TVA and Energy Northwest in full and half of additional commitments to Traxys that we believe have been committed under term contracts.
10. Based on the competitive market theory.

Figure 3.10 Worldwide Baseline Cost Trend- Uncommitted Supply and Demand (Constant 1/1/2014 $/lb)

[redacted]

3.7 Impact of DOE Sales

The sensitivity cost trend in any given year depends on the site forward cost (including ROR) and supply capability of the last property needed to meet demand in a given year, and those same characteristics for the next highest cost properties.

The quantity of DOE material assumed to be sold is shown in Table 3.3.

Table 3.3 DOE Quantities Assumed to Be Sold

	2014	2015	2016	2017	2018	2019
HEU Down Blending						
TVA off-spec transfers	935.0	1,870.0	935.0	0.0	0.0	0.0
American AFS	0.0	0.0	0.0	0.0	0.0	0.0
MOX backup LEU inventory	0.0	0.0	0.0	0.0	0.0	0.0
MOX backup LEU inventory extension	0.0	0.0	0.0	0.0	0.0	0.0
Unallocated HEU	0.0	0.0	0.0	0.0	682.5	682.5
Russian-origin Natural Uranium	6,043.6	6,020.2	1,922.5	0.0	0.0	0.0
U.S.-Origin Natural Uranium	0.0	0.0	4,139.3	6,061.8	3,433.4	0.0
Total	**6,978.6**	**7,890.2**	**6,996.8**	**6,061.8**	**4,115.9**	**682.5**

NAC analyzed the market to determine the impact on the price trend of selling 2,800 MTU per year, 2,400 MTU per year and 10% of U.S. reactor requirements in each year. The analysis was performed based on total and uncommitted demand and supply. The price trend for each year was determined by identifying the incremental cost of the sub-marginal supplier with supply or uncommitted supply needed to meet demand or uncommitted demand. The results of the analyses are shown in Table 3.4 and Table 3.5.

Table 3.4 Impact of DOE Sales Cost Trends, Total Supply Demand

	[redacted]						
	2014	2015	2016	2017	2018	2019	Average
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Basing the analysis on total supply and total demand, the largest impacts on the cost trends is in the early years and the average impact [redacted]. NAC does not believe that this is an accurate way to model the impact of DOE sales. This approach has been included this approach because this is the method previously used by the DOE contractor. This methodology assumes that the lowest cost supply is always used by the market before higher cost supply. It ignores the fact that in the real world some suppliers with higher costs may lock prices that allow them to continue to produce ahead of lower cost supply. Most deliveries in the uranium market are made under term contracts. Therefore NAC believes the proper methodology to model the impact of DOE sales is based on the uncommitted supply available to service the uncommitted demand.

Table 3.5 Impact of DOE Sales Cost Trends, Uncommitted Supply Demand

	[redacted]						
	2014	2015	2016	2017	2018	2019	Average
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

The results show the DOE sales have an impact on the price trend for the years analyzed of between [redacted]

NAC's market-balancing model derives an annual cost trend based on the last increment of uncommitted supply needed in a given year to meet projected uncommitted demand. This cost trend, however, does not include all of the costs for a particular producer. The costs reflect NAC's opinion of *site forward* production costs only, not an estimate of all costs experienced by a producer. This is the approach believed to taken by ERI in its "Quantification of the Potential Impact on Commercial Markets of Introduction of DOE Excess Uranium Inventory in Various Forms and Quantities During Calendar Years 2012 through 2033". In performing its price forecasting NAC normally includes some additional costs to obtain a total incremental cost.

To approximate the *total* incremental cost, the impact of the following factors needs to be considered:

- An estimate for increased site forward costs due to properties operating at less than nominal capacity[11]
- Property and production taxes
- Corporate overhead (e.g., sales and marketing, general and administrative, etc.)
- The possibility that a ROR somewhat higher than the [redacted] assumed in the USAS market-balancing model might be required for some potential properties[12] to move forward toward operation.

Arguably, corporate overhead should not be considered to be an incremental cost for an operating project, as corporate overhead does not generally change with volume of production for a large company. However, it is clear that non-operating properties and smaller operating properties do consider these costs in making decisions. Since many such properties tend to be the marginal suppliers in the future, NAC believes these costs should be included. There are a number of approaches to allocating overheads and taxes. In order to provide consistent methodology, NAC has chosen to use a multiplier.

To account for these factors, NAC believes it is appropriate to apply [redacted]

The range for the assumed multiplier is comprised of two assumed components:

[redacted]

[11]. The USAS cost model is based on estimated capital and operating costs and does not attempt to separate fixed vs. variable costs.
[12]. Properties that are not currently operating, planned or under construction.

In addition, primary producers need to have a price signal in order to begin investing in new production centers. In other words, they need to have prices which justify the investment before actually making the investment. *The other component associated with developing a spot price forecast involves applying a time shift to the cost trend.*

- In the uncommitted supply/demand market balancing exercise used to derive the cost trend shown in Figure 3.10, all of the properties needed in 2014 between [redacted] are already operating or under construction. This suggests the cost trend values for the period through [redacted] should provide the basis for a price forecast in these years without the impact of a time shift.
- Longer term, NAC believes it is reasonable to assume that prices required supporting new primary capacity need to be reflected in spot market prices around three years prior to facility startup. Thus, we believe it is appropriate to apply a three-year time shift that would impact price forecast values starting in [redacted].

[redacted]

A. Other Secondary Supply Sources

A.1 Reprocessed Uranium (RepU)

The recycle of reprocessed uranium today is founded principally on Russian recycle facilities, with the exception of AREVA fabrication capability at the Romans facility in France. Today there are active RepU recycle programs in [redacted]. France today is displacing about [redacted] per year of fresh reload fuel with RepU assemblies. This might grow in the future but we estimate to probably not more than about [redacted] per year. [redacted] recycle may end before the end of this decade. Other recycle in the EU through [redacted] is projected to average about [redacted] per year. [redacted] RepU recycle is difficult to predict, [redacted] RepU to the market, whether directly in [redacted].

Overall therefore we project that RepU will displace approximately [redacted] MTHM per year in [redacted], possibly rising to as much as about [redacted]. The corresponding impact on natural UF_6 displacement on this basis would average approximately [redacted].

A.2 U.S. Department of Energy (DOE) Inventories

An important uncertainty for the front-end nuclear fuel markets is how much material DOE will make available to the market from its inventories. DOE's previous guidance indicated that the annual quantities would be no more than around 10 percent of annual U.S. reactor requirements.

Table A.1 summarizes DOE's uranium inventory situation as of the end of 2012.

Table A.1 DOE Uranium Inventories as of 12/31/12

Inventory	MTU	Material Type	Natural Uranium Equivalent MTU	Natural Uranium Equivalent Million lbs U_3O_8
Unallocated Uranium Derived from U.S. HEU Inventory	18.0	HEU/LEU	3,394	8.8
Allocated Uranium Derived from U.S. HEU Inventory	11.4	HEU/LEU	2,077	5.4
LEU	47.6	LEU	409	1.1
U.S.-Origin UF_6	5,234	Natural uranium	5,234	13.6
Russian-Origin UF_6	7,705	Natural uranium	7,705	20.0
Off-Spec LEU as UF_6	1,106	LEU	1,876	4.9
Off-Spec Non- UF_6	221	Natural uranium/LEU	600	1.6
Depleted uranium as UF_6[a]	114,000	Depleted uranium	25,000-35,000	65-90

a. Having assays greater than 0.34 w/o U^{235} but less than 0.711 w/o U^{235}.

Source: *Excess Uranium Inventory Management Plan*. United States Department of Energy, July 2013, Table 1.

Whenever DOE makes excess inventories available, a determination of no adverse impact on the uranium market is required. Based on the May 15, 2012 Secretarial Determination, the *maximum allowable* quantity of DOE inventories available to the market is as follows:

- 2012-2013: *Up to* 9,156 MTU of depleted uranium (DU) transferred to Energy Northwest (EN); this material would then be enriched to low enriched uranium (LEU) containing 482 MTU equivalent, of which EN would use a portion and the rest of which EN would transfer to the Tennessee Valley Authority (TVA) for use in 2013-2030.
- 2012-2021: *Up to* 2,400 MTU per year of natural uranium to DOE contractors for cleanup activities at the Paducah or Portsmouth enrichment plants
- 2012-2020: *Up to* 400 MTU per year of natural uranium equivalent contained in LEU transferred to National Nuclear Security Administration (NNSA) contractors for use in down-blending HEU

On February 6, 2013, DOE issued a request for expressions of interest (EOI) to “purchase, exchange, or transfer” approximately 114,000 MTU of high-assay DU with a weighted average tails assay of about 0.36 weight percent (w/o) U^{235}. This high-assay DU has assays ranging from 0.341 w/o U^{235} to 0.706 w/o U^{235}. At an assumed secondary tails of 0.25 w/o U^{235} (which NAC estimates would be economically feasible) re-enrichment of this high-assay DU would result in about 27,000 MTU of natural equivalent.[1] DOE indicated that it also has large quantities of low-assay DU with tails assays lower than 0.341 w/o U^{235}. NAC's evaluation of the economics associated with re-enrichment of the high-assay tails suggests that the re-enrichment can be done profitably.

DOE's excess inventory of Russian-origin natural UF_6 is the source of the material that is currently being made available to the uranium market under the May 15, 2012 Secretarial Determination. This material is expected to be exhausted in 2016.[2] In order for DOE to continue to make additional uranium available to the market under the current Secretarial Determination, it will have to use material from one of the other seven inventory categories shown in Table A.1.

NAC believes GLE's planned laser enrichment plant is the most likely candidate for the re-enrichment of DOE's high assay tails. However, NAC believes the GLE plant will not be in operation before 2022. (See Section 5 of this report for more details.)

Table A.2 shows the quantities of natural uranium that, for the purpose of this report, NAC assumes will be available to the market from DOE's inventories in 2014-2030.

Table A.2 Annual Quantities of DOE Uranium Inventories Assumed to be Available to the Market in 2014-2030 (MTU Natural Uranium Equivalent)

	2014	2015	2016	2017	2018	2019	2020	2021	2022-2030
HEU downblend to LEU for TVA off-spec transfers[a]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Russian-origin UF_6[b]	2,320	2,311	738	0	0	0	0	0	0
U.S.-origin UF_6[b]	0	0	1,589	2,327	1,318	0	0	0	0
Natural uranium derived from the re-enrichment of high-assay DU[c]	0	0	0	0	0	0	0	0	2,400
Other DOE excess inventories[d]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

a. Source: Fuel-Trac database
b. Source: *Excess Uranium Inventory Management Plan*, U.S. Department of Energy, July 2013, Table 7.
c. Assumed to be the same as the maximum quantity for 2021 in the 5/12 Secretarial Determination.
d. NAC assumptions

1. If a secondary tails of 0.20 w/o U^{235} (which NAC also estimates would be economically feasible) were assumed, re-enrichment of this high-assay DU would result in an increase of about 32% in the total quantity of natural uranium equivalent.
2. *Portsmouth Site's Source & Uses of DOE Uranium Barter Funds*. Presentation by Frank Hahne and Bruce Hanni of Fluor-B&W Portsmouth LLC at 1/30/13 NEI Nuclear Fuel Supply Forum, slide 2.

A.3 Mixed Oxide (MOX) Fuel

At the moment the only operating MOX fabrication facility is MELOX in France and this situation is not set to change any time soon. [redacted] utilities have confirmed [redacted] to MOX fabrication in MELOX and these will be manufactured through [redacted]. Thereafter the only clear [redacted].

Based on these assumptions, the approximate average annual demand displacements associated with MOX usage would be as follows:[3]

- Natural UF_6:
  [redacted]
- SWU:
  [redacted]

Theoretically it is possible that a U.S. MOX plant could come into operation, to process 34 MT of weapons grade plutonium. However, increasingly this appears to be improbable due to the massive cost escalation that is affecting the project. Even if this were to happen, the market impact would be small with no more than perhaps 50 MTHM of fabricated uranium fuel displaced annually.

A.4 Russian Highly Enriched Uranium (HEU)

The U.S-Russian HEU agreement ended last year. If Russia were to decide to take advantage of the additional market share available under the Domenici legislation (for down-blending an additional 300 MTU of weapons HEU), the additional quota of only about 850,000 SWU per year would be insignificant in the context of global demand.

3. Most of this estimated MOX usage was reflected in the October 2013 Fuel-Trac® database. The demand projections presented in this report reflect slight downward adjustments to reflect the additional estimated quantities not reflected as of October 2013.

A.5 [redacted]

[redacted]

[redacted]

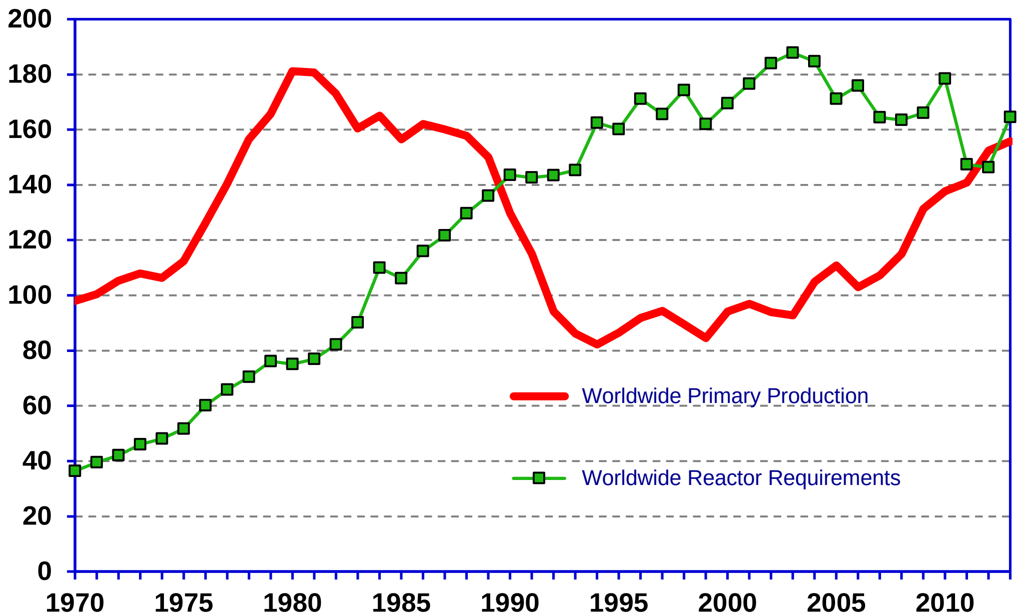
[redacted]

[redacted]

B. Metrics for Primary U_3O_8 Supply Industry

NAC estimates that worldwide primary production in 2013 was about 155.8 million pounds U_3O_8, about two percent higher than in 2012.[1] Figure B.1 compares worldwide U_3O_8 primary production and reactor requirements since 1970. The chart demonstrates that the industry is not very good at matching production to needs. In the early years the industry built a large inventory due to the excess production. This inventory was then reduced over the next 24-year period, when needs exceeded production by about 1.3 billion pounds U_3O_8 equivalent, or about 54.2 million pounds per year.

Figure B.1 Worldwide U_3O_8 Primary Production versus Reactor Requirements Since 1970 (Millions pounds U_3O_8)



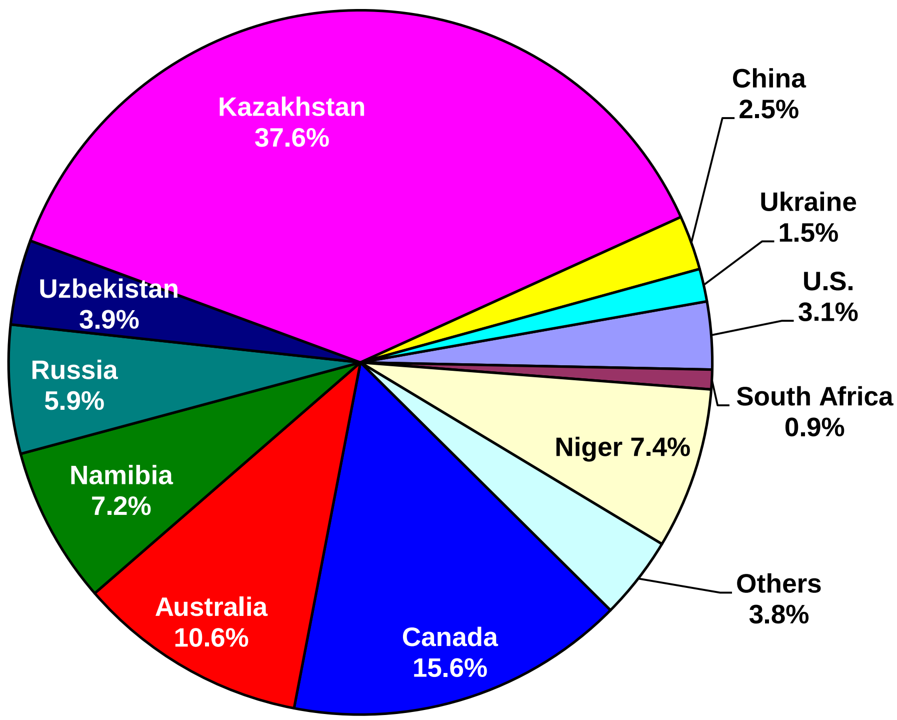
Note: Reactor requirements reflect average tails assay of approximately: 0.30 w/o U^{235} in 1990-2001; 0.32 w/o U^{235} in 2002-2003; 0.30 w/o U^{235} in 2004; 0.27 w/o U^{235} in 2005-2007; 0.25 w/o U^{235} in 2008-2011; and 0.225% in 2012-2013. Almost one-fifth of the decrease in requirements in 2011 was associated with reactor shutdowns in Germany and Japan as a result of the Fukushima accident.

1. Actual production data accounts for 80% percent of the total.

In 2007-2013, NAC estimates that worldwide production increased by 42 percent while reactor requirements increased by only one percent. As a result, the gap between reactor requirements and production decreased by an order of magnitude, from about 62 million pounds (38 percent of reactor requirements) in 2006 to about 9 million pounds (5 percent of reactor requirements) in 2013.

Figure B.2 shows estimated 2013 worldwide primary production by country. Kazakhstan, with about 38 percent, had by far the largest share. The top three countries (Kazakhstan, Canada and Australia) combined accounted for about 64 percent of total world output in 2013.

Figure B.2 Country Distribution of Estimated Worldwide 2013 Primary U_3O_8 Production



For *individual facilities for which actual 2013 production has been reported* and that produced at least 2.5 million pounds last year, three production centers had 2013 production that was more than 10 percent higher than their 2012 output. (See Table B.1). The combined increase from these three facilities totaled about 3 million pounds.

Table B.1 Examples of Production Centers with Significantly Higher Production in 2013[a]

Production Center	Country	Production (Millions lbs U_3O_8) 2012	2013	Increase
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total		12.6	15.6	23.8%

a. More than 10 percent higher than 2012 production based on facilities that produced at least 2.5 million pounds in 2012.

For three production centers in this category, production decreased by more than 10 percent in 2013:

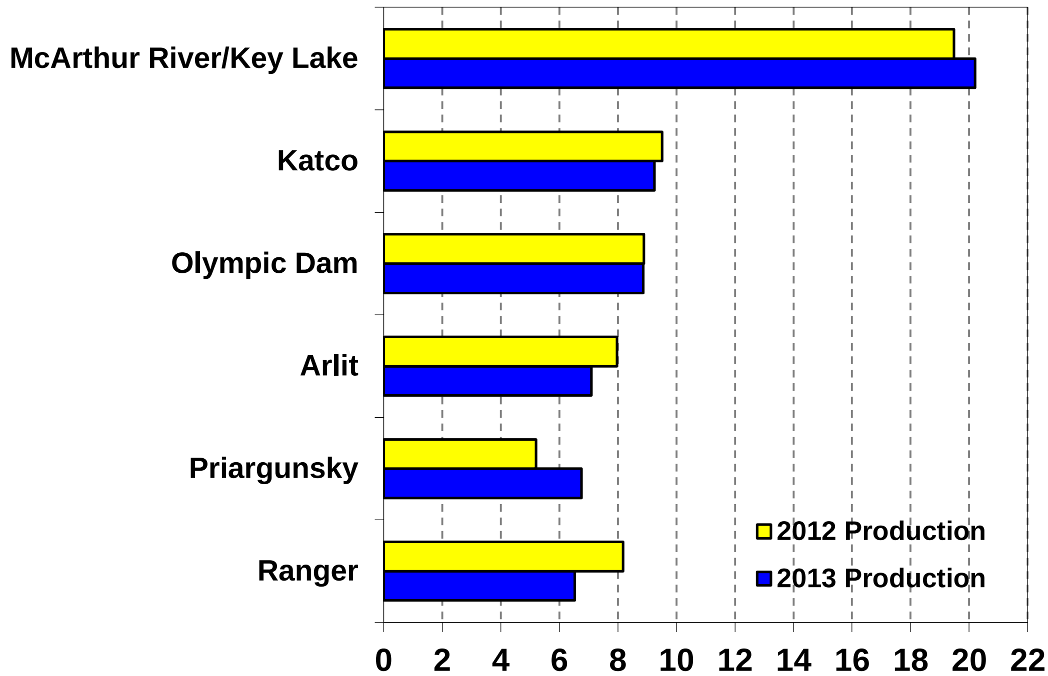
[redacted]

Based on *individual* production centers *for which actual 2013 production has been announced*, Figure B.3 shows production for the top six individual facilities in 2013 compared with their 2012 output. Combined, the top six facilities accounted for 38 percent of estimated worldwide output in 2013. A prolonged disruption in production at any of the larger primary production facilities could have significant implications for the market.

The top two production facilities in 2013 were McArthur River (Canada) and Katco[2] (Kazakhstan) respectively. Olympic Dam (Australia) ranked third followed by Arlit (Niger). Priargunsky (Russia) and Ranger (Australia) ranked fifth and sixth, respectively.

2. Moinkum and Tortkuduk mines

Figure B.3 Comparison of 2012 and 2013 Production for Top Six Individual Primary Production Centers in 2013 for Which Actual 2013 Production Has Been Announced (Millions lbs U_3O_8)



As shown in Table B.2, the estimated average worldwide mill capacity utilization in 2003-2013 was about [redacted]. Interestingly, capacity utilization decreased in 2006, the year in which spot prices experienced their largest annual increase. Higher prices do not always result in high capacity utilization. Although the number of mills that had operational problems in 2006 appears to be an anomaly, it nonetheless serves as a reminder that unforeseen events often occur and future production will undoubtedly continue to be lower than capacity.

The worldwide U_3O_8 production industry has become more consolidated since the late 1980s. (See Figure B.4). As spot prices decreased during most of the 1980s and the first half of the 1990s, larger and more financially stable companies acquired interests in production centers from companies that were less committed to the industry or that did not have the resources to maintain their positions until prices increased. As a result, a smaller group of companies now controls a larger share of primary production.

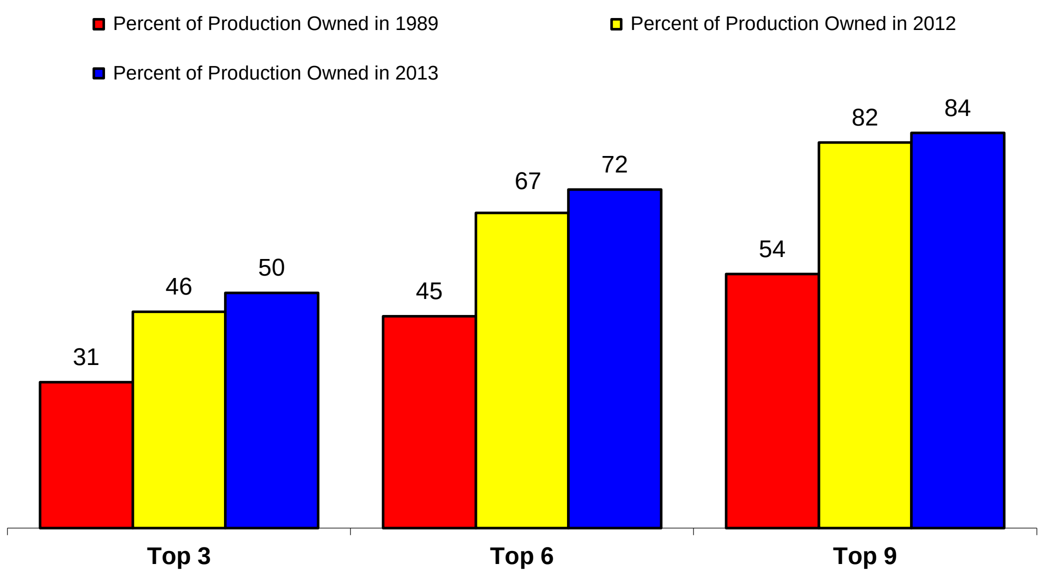
Table B.2 Estimated Worldwide U_3O_8 Milling Capacity Utilization

Year	Estimated Production as Percent of Nominal Capacity	Percent Increase/(Decrease) in Year-End in Spot Price[a]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	

a. 2002-2007: Based on Uranium Price Information System (UPIS) U_3O_8 Spot Price Indicator
2008-2013: Based on TradeTech Exchange Value

b. For a number of Kazakh facilities that are ramping up output, based on NAC estimates of achievable capacity in 2009-2013; percentage would be lower if based on ultimate design capacity for these facilities.

Figure B.4 Concentration of Estimated Worldwide U_3O_8 Primary Production[a]



a. Based on equity ownership interest by companies; does not reflect consolidated (attributable) share of production based on marketing arrangements or off-take agreements. Percentages would be different if marketing arrangements and/or off-take agreements were taken into consideration.

Compared to 2012, production was slightly more concentrated in 2013, due largely to the acquisition of Uranium One by Atomredmetzoloto (ARMZ). The top three companies (Kazatomprom, Cameco and ARMZ, respectively) accounted for 50 percent of the estimated worldwide primary production in 2013. The top six companies (top three plus AREVA, BHP Billiton and Rio Tinto), accounted for 72 percent of the production. The seventh, eighth and nine largest companies in 2012 were Paladin Energy, Navoi Mining and China National Nuclear Corp., respectively.

[redacted]

Figure B.5 [redacted]

a. Based on equity ownership interest by companies; does not reflect consolidated (attributable) share of production based on marketing arrangements.

Table B.3 shows the six companies that have the largest share of estimated worldwide *in-place* reserves.[3] The data reflects ARMZ's acquisition of Uranium One last year. Partially due to this acquisition, ARMZ is now in third place behind BHP Billiton and Kazatomprom.

3. Based on data in the Fuel-Trac database as of 12/30/13

Table B.3 Top Six Holders of Estimated In-Place U_3O_8 Reserves

Rank	Producer	Reserves (Millions of contained lbs. U_3O_8)	Percent of Total	Cumulative Percent of Total
1	[redacted]	[redacted]	[redacted]	[redacted]
2	[redacted]	[redacted]	[redacted]	[redacted]
3	[redacted]	[redacted]	[redacted]	[redacted]
4	[redacted]	[redacted]	[redacted]	[redacted]
5	[redacted]	[redacted]	[redacted]	[redacted]
6	[redacted]	[redacted]	[redacted]	[redacted]

a. Includes Uranium One

The top six producers own [redacted] of the world's in-place reserves, [redacted]

C. Overview of Uranium Supply Analysis System (USAS)

NAC developed the Uranium Supply Analysis System (USAS) production cost estimation model in the early 1980s as an outgrowth of NAC's involvement with utility in-house uranium exploration and development programs. In updating the USAS each year, a variety of published information (annual reports, feasibility studies, technical reports, industry presentations, etc.) is reviewed. NAC then uses the expertise developed over its 40-year involvement in the uranium industry in applying cost estimation methods, aided by mine/mill cost models developed by NAC, to derive cost estimates for individual properties.

A key purpose of the USAS is to provide a basis upon which to compare the relative costs of properties on as consistent a basis as possible. All production cost estimates are given in *constant U.S. dollars* per pound U_3O_8. Due to their small size some of the individual properties would need to be combined with other properties in the surrounding area to constitute a commercially viable production center. As such, *the estimated cost for a given property is not meant to imply that it would necessarily be commercially viable on a stand-alone basis*. In addition, the cost estimates reflect NAC's opinion of only the *site* costs; they exclude corporate overhead and income taxes.

Mainly due to the 450 properties included, the USAS relies heavily on a *model-based approach* for its cost estimates. These estimates are derived based on standardized country models for costs in dollars per ton of ore. Adjustment factors based on known deposit-specific parameters (e.g., depth, host rock, permeability, etc.) are then applied to the standardized models. A confidence range[1] is associated with each cost estimate to reflect inherent uncertainty associated with the estimates.

The USAS capacity projections reflect NAC's judgment of *technically attainable start-up dates (for non-operating properties) and capacities (for all properties) based on each property's current stage of development and estimated reserves.* Of course, actual start-up dates will depend on future market price movements as well as a variety of technical, regulatory and financial factors. Projected capacities for many non-operating properties reflect assumed gradual ramp-up periods during the first few years of operation.

1. [redacted].

Table C.1 gives *default* lead times assumed in the 2013 version of the USA System to derive estimated *technically achievable* startup dates for non-operating properties based on a given property's status. These default lead times are overridden if information that is more definitive is available. Of course, actual startup dates for non-operating properties will depend on future prices as well as political, regulatory, financial and other factors.

Table C.1 Default Lead-Times for Estimated Startup Years for Non-Operating Properties

USA System Status Category	Assumed Lead Time (Years to Startup)	Specific Categories Included[a]
Constructed	[redacted]	[redacted]
Under Construction	[redacted]	[redacted]
Planned	[redacted]	[redacted]
Potential	[redacted]	[redacted]

a. Categories used in NAC's Fuel-Trac® database.
[redacted]

c. [redacted]

A cash flow model utilizing cost estimates based on *life-of-project annual output at capacity* establishes the amount and timing of estimated expenditures used for calculating the estimated costs for a given property.

Full cost estimates *include both sunk and forward capital and operating costs with* [redacted] *rate of return (ROR)*. The ability to cover, *at a minimum*, a property's marginal costs would be the key factor in a company's decision to expand an existing facility or bring a new property into production. Each property's ROR is a *before-tax* return intended to provide for a *minimal cost of capital* based on perceived risk and production status.

Discounted cash flow rate of return (DCFROR) techniques are applied to reflect the timing of capital and operating expenditures. The model generates two *constant-dollar* cost estimates, which represent the revenue required to meet the projected costs at an assumed ROR:

- Full cost
- Forward cost

The *full-cost* estimate includes all costs associated with the property—both sunk costs and costs yet to be incurred. The *forward-cost* estimate includes only those costs that are yet to be incurred—sunk costs are ignored.

The ROR chosen by NAC for each property reflects a before-tax return. The general criteria used to determine the ROR based on the status of an individual property are as follows:

- Operating: [redacted]
- Under construction/development and planned: [redacted]
- Potential (based on estimated resources): [redacted]

The RORs are intended to represent *minimum* required levels. The perceived difference in risk is the main reason for the variations in ROR. Operating properties are assigned the lowest ROR since the risk associated with their operations is the smallest. Properties that are under construction/development and planned have a higher risk factor than operating properties and need a higher ROR to attract the necessary capital investment. Potential properties have an even higher risk factor than under construction/development and planned properties, and thus an even higher ROR is required to justify the investment needed.

D. Fuel-Trac Data Base

NAC International's (NAC's) Fuel-Trac® is a comprehensive and accurate global commercial nuclear fuel cycle data base. Fuel-Trac presents a comprehensive model of supply and demand data in both the front- end and back-end sectors, for each participant in the commercial nuclear fuel cycle.

Fuel-Trac provides accurate estimates of reactor performance based on individual detailed fuel cycle plans which include cycle lengths, refueling dates, enrichments, number of assemblies to be loaded, amount of uranium contained in the fuel assemblies, etc. NAC provides comprehensive tables, graphs and models of individual reactor and utility supply/demand (including uncommitted demand and supply and inventory), also rolled up into country, regional and worldwide summaries.

Every October, NAC publishes Industry Status Reports—six bound volumes of timely information on the activities of every buyer and seller for the commodities and services in the nuclear fuel cycle. Each of these status reports addresses a nuclear fuel cycle segment:

- Nuclear Generation
- U_3O_8
- U_3O_8-to-UF_6 Conversion
- Enrichment
- Light-Water Fabrication
- Spent Fuel/Reprocessing

Each Fuel-Trac status report features:

- Overviews for:
  - Individual countries
  - Country groups
  - Worldwide
- Details for:
  - Utilities
  - Agents
  - Suppliers