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ERI-2142.17-1401

2014 Review of the Potential Impact of DOE Excess Uranium Inventory On the Commercial Markets

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Prepared For:

U.S. Department of Energy
Office of Nuclear Energy

Prepared By:

Thomas B. Meade
Eileen M. Supko

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**1015 18th Street, NW, Suite 650
Washington, DC 20036
USA
Telephone: (202) 785-8833
Facsimile: (202) 785-8834**

NOTICE

This report was prepared for the Office of Uranium Management and Policy in the Office of Nuclear Energy, Department of Energy (DOE) under Task 17 under GSA FABS Contract No. GS-23F0242P and DOE Contract No. DE-DT0000752.

DISCLAIMER

Any views expressed or conclusions made in this independent report are solely the opinion of Energy Resources International, Inc. and do not necessarily represent the views of the Department of Energy.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (continued)

Executive Summary

In July 2013, the U.S. Department of Energy (DOE) issued an Excess Uranium Inventory Management Plan, Report to Congress (2013 Plan). The DOE 2013 Plan states that:

> *DOE holds inventories of uranium in various forms and quantities, including highly enriched uranium (HEU), low-enriched uranium (LEU), natural uranium (NU), and depleted uranium (DU), that are currently held as excess and not dedicated to U.S. national security missions. Much of this uranium has potential value that could play a role in achieving vital DOE programmatic missions.*
>
> *The Office of Nuclear Energy, the Office of Environmental Management, and the National Nuclear Security Administration, are the organizations within DOE that coordinate the management of these excess uranium inventories. On December 16, 2008, DOE issued its Excess Uranium Inventory Management Plan (2008 Plan), setting forth possible uses for these inventories. This updated Excess Uranium Inventory Management Plan (2013 Plan) replaces the 2008 plan and reflects updated and evolving information, programs, and mission needs, including additions to and deletions from the inventory and changes to DOE's uranium management strategy*.[i]

The 2013 Plan also states that:

> *The Department complies with the requirements in Section 3112(d) of the United States Enrichment Corporation (USEC) Privatization Act, when applicable, to ensure that prior to covered sales or transfers of natural or enriched uranium, the Secretary of Energy determines that those transfers will not have an adverse material impact on the domestic uranium mining, conversion or enrichment industry (Secretarial Determination).*

The most recent multi-year Secretarial Determination for the sale or transfer of natural or enriched uranium was issued by the Secretary of Energy on May 15, 2012 (May 2012 Determination). It covered DOE transfers that were planned or under consideration by DOE through 2021. Section 306(a) of the Consolidated Appropriations Act of 2014 requires that:

> *Any determination (including a determination made prior to the date of enactment of this Act) by the Secretary pursuant to section 3112(d)(2)(B) of the USEC Privatization Act (110 Stat. 1321-335), as amended, shall be valid for not more than 2 calendar years subsequent to such determination.*

[i] U.S. Department of Energy, Excess Uranium Inventory Management Plan, July 2013 (2013 Plan), pg. iv.

DOE requested that Energy Resources International (ERI) perform this new market impact study in support of the planned DOE process to fulfill the requirements of Section 306(a) of the Consolidated Appropriations Act of 2014, as noted above. This market impact study presents the results of an updated business analysis performed by ERI of the potential impact on the commercial markets associated with the introduction of DOE excess uranium inventories in various forms and quantities during the period 2014 through 2033.

This market impact study is based on DOE planned uranium sales and transfers during the period 2014 to 2033, based on information concerning quantities and schedules provided to ERI by DOE. The sales and transfers include ongoing quarterly transfers of natural UF_6 by DOE's Office of Environmental Management (EM) to the DOE contractor, Fluor-B&W Portsmouth LLC (FBP), for services being provided to DOE in support of the environmental cleanup of the Portsmouth gaseous diffusion plant (GDP); transfers of LEU resulting from the down blending of HEU by the National Nuclear Security Administration (NNSA); prior transfers of off-spec HEU in the Blended Low-Enriched Uranium (BLEU) program with the Tennessee Valley Authority (TVA); the prior transfer of high assay depleted uranium tails (DUF_6) to Energy Northwest (ENW); and the proposed transfer of additional DUF_6, off-spec LEU, and off-spec non-UF_6 that are currently under negotiation with selected companies, as a result of earlier DOE Requests For Offers (RFOs).[ii] The quantities provided in the 2013 Plan have been updated to reflect the most recent status of existing initiatives and current plans.

Current Market Conditions

The global uranium, conversion and enrichment industries are all in a state of considerable over-supply, with mainly discretionary near-term demand for nuclear fuel and a decline of long-term contracting over the past year. While long-term prospects for nuclear power growth and subsequent growth in fuel supply are generally viewed as positive, particularly for the uranium market, the amount of time it will take to recover from the post-Fukushima-driven state of the current markets is unclear. It is clear that excess supply will need to be reduced before any recovery in market price can take place. In the meantime, the domestic industries are feeling the effects of the oversupplied markets and are taking actions, such as production and staffing cutbacks, in order to try to weather the downturn. The impacts are most acute in the uranium and conversion industries.

DOE Inventories Addressed by Market Impact Study

There are three broad categories of material for which DOE inventory is expected to enter the commercial markets during the period of time that is addressed by this analysis (2014 through 2033). They are (i) historical DOE transfers that will continue to displace commercial supply in the market in the future, (ii) ongoing inventory transfers in exchange for services (barters), and (iii) proposed transfers of DOE inventory, including additional

[ii] U. S. DOE, Portsmouth/Paducah Project Office, Request for Offers for the Sale of Depleted and Off-Specification Uranium Hexafluoride Inventories, Request for Offers Number: DE-SOL-0005845, July 3, 2013.

DUF_6, off-spec LEU, and a limited amount of off-spec non-UF_6 that are currently under negotiation with selected companies, as a result of an earlier DOE RFOs. Each is addressed separately and then they are combined for further evaluation.

Historical DOE transfers refer to inventories that DOE transferred in the past, some of which has not yet been introduced into the commercial markets but that will displace commercial supply in the market in the future. These historical transfers include transfers of off-spec HEU to the TVA and high assay DUF_6 to ENW. In each case, the transferred DOE inventories were processed (down blended or re-enriched) and the resulting LEU product loaded into company reactors over a period of many years – the final reload of material that was transferred to TVA is scheduled for 2016 and the material transferred to ENW will displace commercial supply in the market during the 2015 to 2029 time period. For purposes of evaluating the impact of the previously transferred inventories on the commercial markets and U.S. industry, it is appropriate to evaluate the impact according to the schedule of the delivery of the processed inventory as reactor fuel, rather than the initial transfer schedule of the unprocessed inventory.

Ongoing inventory transfers in exchange for services (barters) include DOE NNSA LEU transfers from the down blending of HEU and EM transfers of UF_6 to FBP. The NNSA LEU entering the commercial markets is a result of the down blending of DOE excess HEU by a NNSA contractor, which receives a portion of the 4.95 weight percent (w/o) uranium-235 (U^{235}) LEU created from the HEU down blending as barter in lieu of payment for its services. In order to perform the down blending of the HEU, diluent in the form of natural uranium is purchased from the commercial market. The diluent provides approximately 10% of the equivalent uranium content in the 4.95 w/o LEU. NNSA expects to continue down blending additional HEU through the year 2022. DOE EM is presently making quarterly transfers of natural UF_6 to its contractor, FBP, for services being provided to DOE in support of the environmental cleanup of the Portsmouth GDP. These EM UF_6 inventory transfers are expected to continue until DOE inventories of Russian and U.S. origin UF_6 are exhausted.

The May 2012 Determination indicated that the total quantity of material expected for EM and NNSA barters was 2,800 MTU per year, which included 2,400 MTU per year for EM barters through 2021 and an additional 400 MTU per year transferred to NNSA contractors for HEU downblending through 2020. The DOE 2013 Plan estimated that the quantity of equivalent UF_6 associated with the combined EM and NNSA barters would be 2,705 kgU, which included an estimated 2,320 to 2,330 kgU for EM barters, with the remaining 375 to 385 kgU going to NNSA barters. The NNSA barters used to fund HEU down blending activities are now expected to increase as a result of lower market prices for the 4.95 w/o LEU product. NNSA now anticipates that the NU equivalent of the bartered LEU could total as much as 650 MTU per year, but DOE plans to limit the total NU equivalent in the EM and NNSA barters to 2,705 MTU per year. As a result, the EM barters will decrease and be limited to 2,055 MTU per year if the NNSA barters reach 650 MTU.

In May 2011, Traxys North America LLC (Traxys)[iii] announced that it had entered into an agreement for the purchase of all natural UF_6 through 2013 that the DOE contractor, FBP, expected to receive from DOE. That agreement was extended and Traxys continues to be responsible for introducing all EM barter material into the commercial market. The Traxys announcement noted that *"FBP moved away from the previous practice of spot market auctions…wishing to avoid any impact upon the market,"* a strategy which has been reiterated by Traxys. Traxys has indicated that it is introducing this material into the commercial markets through an equal mix (by volume of material) of spot market (50%) and term (50%) market transactions.[iv] Traxys has also stated that its deliveries of EM barter material are evenly divided between U.S. and non-U.S. customers. As a large and established metals trader, Traxys is able to warehouse the EM barter material as needed in order to ensure its efficient introduction into the commercial markets.

Proposed transfers of DOE inventory include additional high-assay[v] DUF_6 which is considered to be economically viable by the purchaser for the purpose of enrichment to NU-equivalent or to LEU. In 2013, DOE released a RFO for its remaining inventories of high-assay DUF_6, as well as for small quantities of off-spec LEU.[vi] The RFO specified that natural uranium created from the DUF_6 could not enter the market before 2019 and would be limited to 2,000 MTU per year.

At the end of November 2013, DOE announced it would open negotiations with Global Laser Enrichment (GLE) for the sale of high-assay DUF_6. GLE proposed to license, construct and operate a new laser enrichment facility at the site of the shutdown Paducah GDP for the processing of the tails material. The proposed Paducah Laser Enrichment Facility would re-enrich the DUF_6 to 0.711 w/o, creating natural uranium in the form of UF_6 that would then be sold into the uranium market.

In addition to the DUF_6, the unallocated DOE excess inventories include a small quantity (1,327 MTU) of off-spec non-UF_6. In November 2013, DOE also announced that it had entered into negotiations with AREVA for the sale of this material. DOE expects that a portion of this material will enter the commercial markets between 2014 and 2023. In addition, in 2009 the Portsmouth DOE environmental remediation contractor issued a Request for Proposal to sell certain Off-Spec Non-UF_6 material. No decision has yet been made as to whether any material will be sold under that RFP.

[iii] Traxys is a major participant in the financing, marketing, distribution and financial services for the global mining, metals and minerals industries.

[iv] Smith, Kevin, Director Uranium Trading and Marketing, Traxys, Commercial View of DOE's 2013 Plan for Natural Uranium Barter Sales, Nuclear Energy Institute, International Uranium Fuel Seminar, October 6-9, 2013, San Antonio, Texas.

[v] DOE considers DUF_6 with an assay of 0.34 w/o U^{235} or higher to be economic. DOE's inventory of such high-assay DUF_6 is 114,000 MTU as DUF6.

[vi] U. S. DOE, Portsmouth/Paducah Project Office, Request for Offers for the Sale of Depleted and Off-Specification Uranium Hexafluoride Inventories, Request for Offers Number: DE-SOL-0005845, July 3, 2013.

During the period 2014 to 2033, the total DOE inventory entering the market equals about 49,000 MTU as UF_6, which is equivalent to 129 million pounds of U_3O_8. A total of 9.7 million SWU will enter the market during the period 2014 to 2023. No additional equivalent SWU are identified to enter the market after 2023. The DOE inventory transfers that are expected to displace commercial supply in the markets over the next ten years (2014 through 2023) average nearly 2,850 MTU as UF_6, equivalent to 7.4 million pounds U_3O_8 per year. This is equivalent to approximately 15% of annual U.S. uranium requirements and 15% of U.S. conversion requirements. During the subsequent ten years (2024-2033) the DOE inventory entering the commercial uranium market declines to an average of 5.5 million pounds per year, or nearly 12% of U.S. uranium requirements.

The equivalent enrichment services contained in DOE inventory entering the market over the next ten years averages 0.97 million SWU per year. This is equivalent to 6% of U.S. requirements. No additional enrichment services from DOE inventory is expected to enter the commercial enrichment market in the subsequent ten years.

Nuclear Fuel Market Impacts

ERI continues to believe that the change in market price due to DOE inventory entering the market provides an important measure of the DOE material's impact on the domestic industry. However, there is no absolute measure of the isolated effect any one particular market factor or event, such as the DOE inventory material, has on market prices. There are many market factors which combine to determine the relationship between supply and demand, and ultimately market prices as found in published price indicators. DOE inventory entering the commercial markets is certainly one of the market factors, but the DOE inventory must be judged in the context of its relative importance when compared to other market factors. A reasonable judgment on the specific contribution of DOE inventories to observed market price changes can then be made.

A market clearing price approach has been employed to determine the effect of changes in individual components of supply on market prices. ERI chose the market clearing approach because it assumes an efficient allocation of resources in a competitive market and is consistent with the view that long term prices are determined by production costs and future supply-demand forecasts. Using this approach also allows the price impact of any single supply component, such as DOE inventory, to be estimated. This market clearing approach requires the creation of an annual supply curve. Note that the supply curve always assumes secondary supply is utilized first, followed by primary production. In over supplied markets, such as the current uranium market, the amount of mine production required to meet requirements, including normal strategic inventory building, is well below actual production. The results of ERI's market clear price analysis indicate that the price impact attributed to DOE inventory entering the uranium market averages $3 per pound over the period 2014-2023. This is equivalent to 8% of the current spot price and 6% of the current term price. The price impact attributed to DOE inventory entering the conversion market averages $1 per kgU as UF_6 over the next ten years. This is equivalent to 12% of the current spot price and 6% of the current term price. The price impact attributed to DOE inventory entering the enrichment market averages $4 per SWU over the next ten years.

This is equivalent to 4% of the current spot price and term price. As a point of comparison, it is noted that uranium price indicators have declined by 50% for the spot market and 35% for the term market in the three years following the Fukushima accident.

ERI has also developed a multivariable correlation between the monthly spot market prices for uranium concentrates published by TradeTech and the monthly spot market values of supply and demand, which are also published by TradeTech. This correlation covers the period from July 2004 through March 31, 2014 and has an R^2 = 90%, which indicates reasonable agreement, particularly given the extreme volatility experienced in the spot market price during this period. This correlation was used to simulate the 2009 through 2021 spot market price for uranium concentrates with and without the DOE inventory entering the spot market. The results of applying this correlation are projections of a potential spot market price decrease of $2.8 per pound U_3O_8 over the next three years (2014-2016) rising to an average decrease of $5.5 between 2017 and 2021 as spot market prices recover. This represents an estimated impact on spot market price of 7% to 9% from DOE inventory entering the uranium market.

In addition to quantifying the impact of DOE inventory on the price of uranium, conversion and enrichment, this market impact study addresses additional metrics such as employment, production, volumes of inventory relative to market volumes, market capitalization, realized prices and productions costs in the uranium market. The DOE inventory's role relative to other market factors is examined as well. Impacts, in addition to market price impacts associated with DOE inventory entering the conversion market, include impacts on U.S. converter sales volume, production costs, and the reduction in workforce associated with reduced sales volumes.

Uranium Market Impacts

Employment: According to data collected by the U.S. Energy Information Administration (EIA), total U.S. uranium industry employment has ranged between 321 and 1,563 person-years over the past 20 years. U.S. uranium industry employment over the past ten years appears to respond to changes in uranium price, with changes in industry employment from year-to-year being well correlated to the two-year average spot market prices (current and preceding year) in constant dollars. Using the price to employment correlation, industry 2013 employment is expected to decline by approximately 120 person-years from the 2012 value, a 10% decrease and an additional decline of approximately 90 is estimated for 2014. The price-employment correlation has been used to estimate the impact of the DOE inventory releases on U.S. uranium industry employment. The estimate of the impact of DOE material on market price in 2013 is $3.4/lb, resulting in an estimated employment loss of 50 person-years as a result of the DOE inventory entering the market. This corresponds to a reduction in uranium industry employment of 4.4% in 2013. Looking forward, the impact of DOE uranium inventory entering the commercial market is expected to average nearly $3/lb over the next ten years (2014-2023). This results in an estimated long-term employment loss of 44 person years, meaning that future employment is reduced by approximately 4% on average as a result of the DOE inventory releases.

Production: While U.S. uranium industry production has risen since 2003 and continued to rise after the start of the DOE uranium inventory barters in December 2009 as well as during the market decline in 2013, there has been an impact to the actual and planned production of some U.S. operations. There have been announced cutbacks in existing U.S. uranium production in 2012 and 2013 including Energy Fuels placing several mines on standby, Uranium One halting the development of new well fields at Willow Creek, and Uranium Energy Corporation deferring capital expenditures and reducing operation at Palangana. The combined reduction in production from these cutbacks was limited in 2013 but is expected to be about 1.0 million pounds in 2014. Total U.S. production is expected to increase in 2014 as new production more than offsets the cutbacks.

DOE Inventory Relative to Total Market Supply: The DOE inventory's share of total uranium market supply has grown from about 1% in 2008 to 4% currently. Comparison of DOE inventories relative to total secondary supply for uranium shows that DOE inventory has grown from 4% of secondary supply in 2008 to 17% in 2013. Secondary supply declines in 2014 with the end of the HEU Agreement, resulting in an increase in the DOE inventory's share of total secondary supply to approximately 19%. Comparison of DOE inventory entering the spot market against total spot market volume shows that the DOE material sold on the spot market has increased from 1% in 2009 to about 5% in 2010-2012 and 9% in 2013. The DOE material sold on the spot market is expected to remain at levels similar to 2013 for the next ten years.

DOE Inventory Relative to Other Market Factors: Some of the primary market factors that have impacted the uranium supply-demand balance include: loss of uranium demand in Japan and Germany following the Fukushima accident in 2011; increases in uranium demand worldwide (outside of Japan and Germany); the end of the U.S. Russian HEU Agreement in 2013; increased uranium production in Kazakhstan; changes in other secondary supply sources included enricher underfeeding and upgrade of DUF_6 tails in Russia. Comparing market factors that contributed to 2013 supply excess relative to 2008 shows that the increased supply from the DOE inventory entering the market was responsible for about 10% of the total of all market factors increasing excess supply in 2013 and a projected 8% for 2014. If DOE inventory entering the commercial markets had remained at 2008 levels then the net supply excess for 2013 and 2014 would decline by 15% to 20%, but the uranium market would still be considerably over-supplied. The DOE inventory can only be considered responsible for a portion of the decline in market prices observed since the Fukushima event.

Market Capitalization: Market capitalization[vii] is an important metric for the smaller, publicly traded mining companies in the U.S. because it is representative of the ability of these companies to raise funds needed to move projects through the licensing process, which can take many years, as well as initial project development in some cases. Review of market capitalization for U.S. uranium producers shows that it is sensitive to changes in the spot market price, particularly for smaller mining companies. For example, during 2010, spot price increased from $40 per pound up to $70 per pound, an increase of 75%. The

[vii] Share price multiplied by number of outstanding shares.

market capitalization of the smaller U.S. miners increased 150% to 600% in response. Following the Fukushima accident in March 2011, market capitalization declined rapidly. While the impact of large changes in the spot market price is obvious, the effect on market capitalization from the smaller price changes attributed to DOE inventory entering the market is not as clear. It is of interest to note that the market capitalizations have been increasing during the last six months even though market prices have declined.

Realized Prices: The EIA publishes average delivered price in the U.S., which have increased steadily over the past ten years, before leveling off in 2012. While EIA has not yet published data for year-end 2013, a small decline is expected by ERI. The EIA average delivered price in the U.S. is representative of realized prices for the uranium industry on a global basis. Realized prices for the U.S. uranium supply industry varies from one company to another. ERI reviewed realized prices as reported in uranium producers' public filings, representing 95% of U.S. production in 2013. Comparing realized prices to the spot market price during the period 2011 to first quarter 2014 shows that some mining companies' realized prices are spot-market based while others have hedged their exposure to the spot market by locking in prices using a base price escalated approach for a portion of their portfolio. Less than 30% of the production came from companies that were effectively unhedged (no long-term contracts with higher fixed prices).

Production Costs: The EIA reports total industry expenditures for U.S. uranium production, including facility expense, in its annual Domestic Uranium Production Report. The total for 2012 was $187 million, or an average of $45 per pound when spread across 2012 uranium production of 4.15 million pounds in 2012. These costs have been rising since 2010. If DOE inventory were removed from the market, effectively adding back the $2 to $3 per pound price impact attributed to the DOE inventory material, it is unlikely that current market prices would rise enough to cause current production centers to ramp wellfield development and production activities back up. The resulting price level of $36 to $37 per pound would remain less than $40 and may still not be sufficient for some ISL producers to restart wellfield development activities, and likely would not have prevented the decisions to cut back production. If market prices remain at the current depressed levels for several years, which seems to be the consensus view of many in the industry, then more U.S. production will be impacted and may be put on standby, as existing longer term contracts at higher prices are completed and can only be replaced by new, lower-priced contracts.

Conversion Market Impacts:

Impact on Conversion Services Sales Volume: In 2014, DOE inventory expected to impact the conversion market totals 3 million kgU, a value that is indicative of the entry of planned DOE inventories over the next seven years and that is somewhat higher than the average 2.5 million kgU annual DOE inventory expected to enter the market through 2033. An estimated 2 million kgU, or 66% is expected to be sold into the U.S. market and 1 million kgU, or 34% is expected to be sold into the remaining world market. Estimating that Converdyn's pre-Fukushima sales volume ranged from 10 million to 12 million kgU as UF_6 and estimating its U.S. and world market shares, the introduction of DOE inventory

into the conversion market results in a sales volume impact of 0.6 to 0.7 million kgU, which is a 7% to 8% reduction in sales volume. This is on top of Converdyn's stated 25% sales volume loss associated with Fukushima.

Comparison of DOE Inventory with Other Secondary Supply Volumes: Total secondary market supplies in 2014 are expected to be approximately 16.5 million kgU. The DOE inventory represents 18% of secondary market supply in 2014, enricher underfeeding will be 29%, upgrade of tails in Russia will be 32%, plutonium and uranium recycle will be 16% and Russian HEU feed will be 4% of secondary market supply. Converdyn's sales volume is also impacted by the presence of these other secondary market supply sources in the market.

Impact on Conversion Services Production Cost: As noted above, DOE inventory is projected to have a 7% to 8% impact on Converdyn sales volume in 2014. The production of UF_6 has high fixed costs. The loss of sales volume associated with DOE the entry of DOE material in the conversion market, assuming that the fixed portion of production costs range from 80% to 100%, results in a production cost increase of 6% to 8%.

Workforce Reduction Associated with Volume Reduction: Prior to the 2012-2013 temporary shutdown of Metropolis Works for seismic upgrades, the work force was approximately 334. When the plant returned to production in July 2013, the workforce was 270 employees, 80% of the pre-shutdown workforce. According to plant managers, the decrease in work force was due to lower market demand, a portion of which was the result of the impact of DOE inventory on Converdyn sales volume as summarized above.

Enrichment Market Impacts

Enrichment Market Volume Impact: The current over-supply in the enrichment market is due primarily to Fukushima-related demand loss and the subsequent increase in inventories of EUP, with enrichers having excess capacity above enrichment requirements. The release of approximately 1 million SWU per year associated with the entry of DOE inventory into the market during the period 2014 to 2023 represents 1.7 - 2.5% of worldwide enrichment services demand and 6-7% of U.S. enrichment services demand over this period.

Enrichment Price Impact: Enrichment market prices have declined (-39% spot market, -37% term market) since the Fukushima event three years ago. The price impact attributed to DOE inventory entering the enrichment market averages $3.9 per SWU over the next ten years. This is equivalent to 4% of the current spot price and term price.

The overall status and changes in the nuclear fuel markets have been characterized in this market impact study; however, it is more difficult to attribute the relative "responsibility" of each of the many factors which influence the market price indicators. While the DOE inventory releases clearly play a role, they must be judged in context of all market factors including reduced demand following the accident at Fukushima Daiichi. This market impact study has estimated impacts from the transfer of DOE inventory and its subsequent displacement of commercial supply in the markets, which represent a share or fraction of

all the changes which have taken place over the past two to three years. For example, as discussed above, comparing market factors that contributed to 2013 supply excess relative to 2008 supply shows that the increased supply from the DOE inventory entering the market was responsible for about 10% of the total of all market factors increasing excess supply in 2013 and a projected 8% for 2014. If DOE inventory entering the commercial markets had remained at 2008 levels then the net supply excess for 2013 and 2014 would decline by 15% to 20%, but the uranium market would still be considerably over-supplied. The DOE inventory can only be considered responsible for a portion of the decline in market prices observed since the Fukushima event.

Predictability

As stated by ERI in its 2012 market impact study, the predictability of DOE's inventory transfers into the commercial markets over time is very important to the orderly functioning of the nuclear fuel markets. In this regard, it is critical for long-term planning and investment decisions by the domestic industry that there can be confidence that DOE will adhere to what it presents as being established guidelines and plans. In the 2013 DOE Plan, DOE stated that it "***determined that it can meet its statutory and policy objectives in regard to DOE uranium sales or transfers without an established guideline***." Based on feedback that ERI received from representatives of the U.S. uranium and conversion industries, the decision by DOE to no longer have an established guideline that would limit DOE inventory transfers to 10% of U.S. requirements was interpreted by the U.S. industry and investment community as an indication that DOE will not act in a predictable manner regarding future inventory releases. The ERI 2012 market impact study also stated that unless DOE can demonstrate to the domestic fuel supply industry that its transfer of material during any year(s) will remain predictable and that DOE will not make future transfers without any regard for the "***maintenance of a strong domestic nuclear industr***y", then DOE actions may, in fact, have an adverse material impact on the domestic industry. It is important to note that the inventory transfer levels that DOE specified for use in this 2014 market impact analysis are consistent with the May 2012 Determination through the year 2020. While DOE has taken steps towards improved[viii] predictability since the release of the 2013 Plan, it is not clear that this standard been met – certainly not in the view of domestic industry.

Final Notes

It is clear that there have been production, employment and financial impacts on the domestic industry due to a variety of market factors culminating in the current oversupplied markets. Based on the analysis contained in this study, it is not clear that a reduction in DOE inventory releases would cause the overall market conditions to change enough to make a significant difference in the health and status of the domestic industries. However, based on feedback that ERI received from representatives of the U.S. uranium and

[viii] The most recent RFO for additional DUF_6 specifically states that resulting natural UF_6 cannot enter the markets prior to 2019 and limits the quantities to 2,000 MTU per year. DOE also plans to lower the quantity of EM barters to compensate for possible increases in NNSA barters due to lower market prices.

conversion industries, they clearly feel that a reduction in the amount of DOE inventory entering the markets would make a difference, in part by sending a strong signal to the markets that DOE recognizes the current weak state of the nuclear fuel markets, in which there is considerable oversupply, near-term demand is mostly discretionary, and long-term contracting has declined considerably over the past year, and that DOE is responding to these market conditions.

In the context of a much stronger price environment, the market impact study conducted by ERI two years ago judged, at that time, that the impacts of the DOE inventory releases were small enough so as to not constitute a material adverse impact. DOE and ERI sought to clarify ERI's role in the development of this market impact study. ERI's role is to analyze the impacts associated with the release of DOE inventories into the commercial markets for the period 2014 to 2033. In accordance with the USEC Privatization Act, any determination of "adverse material impact" is made by the Secretary of Energy. As such, this market impact assessment does not make any conclusion regarding whether or not the release of DOE inventories into the commercial markets will result in an adverse material impact.

1. Introduction

In July 2013, the U.S. Department of Energy (DOE) issued an Excess Uranium Inventory Management Plan, Report to Congress (2013 Plan). The DOE 2013 Plan states that:

> *DOE holds inventories of uranium in various forms and quantities, including highly enriched uranium (HEU), low-enriched uranium (LEU), natural uranium (NU), and depleted uranium (DU), that are currently held as excess and not dedicated to U.S. national security missions. Much of this uranium has potential value that could play a role in achieving vital DOE programmatic missions.*
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> *The Office of Nuclear Energy, the Office of Environmental Management, and the National Nuclear Security Administration, are the organizations within DOE that coordinate the management of these excess uranium inventories. On December 16, 2008, DOE issued its Excess Uranium Inventory Management Plan (2008 Plan), setting forth possible uses for these inventories. This updated Excess Uranium Inventory Management Plan (2013 Plan) replaces the 2008 plan and reflects updated and evolving information, programs, and mission needs, including additions to and deletions from the inventory and changes to DOE's uranium management strategy*.[1]

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> *The Department complies with the requirements in Section 3112(d) of the United States Enrichment Corporation (USEC) Privatization Act, when applicable, to ensure that prior to covered sales or transfers of natural or enriched uranium, the Secretary of Energy determines that those transfers will not have an adverse material impact on the domestic uranium mining, conversion or enrichment industry (Secretarial Determination).*

In addition, the 2013 Plan noted that the "*2008 Plan included reference to a Departmental guideline that, as a general matter, the introduction into the domestic market of uranium from Departmental inventories in amounts that do not exceed 10 percent of the total annual fuel requirements of all nuclear power plants should not have an adverse material impact on the domestic uranium mining, conversion or enrichment industry*." The 2013 Plan goes on to state that the "*Department has determined that it can meet its statutory and policy objectives in regard to DOE uranium sales or transfers without an established guideline. In addition, decisions to introduce uranium into the market pursuant to section 3112(d) must be reviewed every two years. Accordingly, the 10 percent guideline will no longer be used*."

[1] U.S. Department of Energy, Excess Uranium Inventory Management Plan, July 2013 (2013 Plan), pg. iv.

The most recent multi-year Secretarial Determination for the sale or transfer of natural or enriched uranium was issued by the Secretary of Energy on May 15, 2012 (May 2012 Determination). It covered DOE transfers that were planned or under consideration by DOE through 2021. Section 306(a) of the Consolidated Appropriations Act of 2014 requires that:

> *Any determination (including a determination made prior to the date of enactment of this Act) by the Secretary pursuant to section 3112(d)(2)(B) of the USEC Privatization Act (110 Stat. 1321-335), as amended, shall be valid for not more than 2 calendar years subsequent to such determination.*

DOE requested that Energy Resources International, Inc. (ERI) perform a new market impact study in support of the planned DOE process to fulfill the requirements of Section 306(a) of the Consolidated Appropriations Act of 2014, as noted above. This market impact study presents the results of an updated business analysis performed by ERI of the potential impact on the commercial markets associated with the introduction of DOE excess uranium inventories in various forms and quantities during the period 2014 through 2033.

This market impact study is based on DOE planned uranium sales and transfers during the period 2014 to 2033, based on information concerning quantities and schedules provided to ERI by DOE. The sales and transfers include ongoing quarterly transfers of natural UF_6 by DOE's Office of Environmental Management (EM) to the DOE contractor, Fluor-B&W Portsmouth LLC (FBP), for services being provided to DOE in support of the environmental cleanup of the Portsmouth gaseous diffusion plant (GDP); transfers of LEU resulting from the down blending of HEU by the National Nuclear Security Administration (NNSA); prior transfers of off-spec HEU in the Blended Low-Enriched Uranium (BLEU) program with the Tennessee Valley Authority (TVA); the prior transfer of high assay depleted uranium tails (DUF_6) to Energy Northwest (ENW); and the proposed transfer of additional DUF_6 and off-spec non-UF_6 currently under negotiation with selected companies, as a result of earlier DOE Requests For Offers (RFOs).[2] The quantities provided in the 2013 Plan have been updated to reflect the most recent status of existing initiatives and current plans. While the prior DOE transfers of off-spec HEU to TVA and the transfer of DUF6 to ENW have already taken place, this material will be loaded into company reactors over a period of many years. For purposes of evaluating the impact of these prior transfers on the commercial markets and U.S. industry, it is appropriate to evaluate the impact according to the schedule of the delivery of the processed inventory as reactor fuel, rather than the initial transfer schedule of the unprocessed inventory.

Section 2 provides background information on each of the nuclear fuel markets that would potentially be affected by DOE inventory entering the markets for uranium concentrates, conversion services, and enrichment services. For each of these markets, both spot and

[2] U. S. DOE, Portsmouth/Paducah Project Office, Request for Offers for the Sale of Depleted and Off-Specification Uranium Hexafluoride Inventories, Request for Offers Number: DE-SOL-0005845, July 3, 2013.

term price indicators are presented as well as a projected supply-demand balance. This information serves as a basis for understanding the relative importance of the quantities of DOE material that might enter the markets. It also provides additional perspective with regard to the potential impact of DOE inventory entering the commercial markets relative to published market prices.

Section 3 identifies and discusses the quantities of equivalent DOE natural uranium and enrichment services expected to be introduced into the commercial markets during the time period addressed by this analysis (2014 - 2033). The categories of material include (i) historical DOE transfers still entering the commercial markets, (ii) ongoing inventory transfers in exchange for services (barters), and (iii) proposed transfers of additional DUF_6, off-spec LEU, and off-spec non-UF_6 that are currently under negotiation with selected companies as a result of earlier DOE RFOs.

Section 4 presents quantitative and qualitative estimates of the potential effect of entry of DOE equivalent materials and services into the domestic uranium, conversion and enrichment markets. The potential impact is evaluated using market clearing price analysis[3], as well as an econometric model of the spot market price for uranium concentrates. In addition to addressing the effect of DOE inventory on market clearing price, other metrics associated with the domestic uranium and conversion industries are evaluated including: employment, production, volumes of inventory relative to market volumes, market capitalization, realized prices and production costs for the uranium production industry; and U.S. converter sales volumes, production costs and workforce reductions; and impact on volumes of enrichment services.

Section 5 provides a summary of the concerns and views expressed by the domestic industry. ERI believes that its analysis has captured many of the additional metrics raised by U.S. uranium producers and Converdyn. The inclusion of the industry views represents neither an endorsement nor a critique by ERI.

Section 6 provides a final summary of the potential market impacts developed in this report.

[3] In any particular year, the market clearing price (or equilibrium price) for uranium concentrates, for example, is based on the cost of production of the last increment of uranium that must be supplied by the market in order to provide the total quantity of uranium concentrates that is demanded by the market during that year.

2. Background on Nuclear Fuel Supply Markets

In order to better understand the potential impact that DOE inventory entering the commercial markets could have for nuclear fuel materials and services, it is useful to have some background regarding the current status of each of these markets. At a minimum, this allows an understanding of (i) the relative size of the DOE market entries in the context of each of these markets, (ii) the manner in which published market prices have behaved in the past, and (iii) how the potential price impacts associated with entry of DOE inventory into the nuclear fuel markets compare to these market prices.

The ERI Reference Nuclear Power Growth requirements forecasts used in this analysis were developed on a plant-by-plant and country-by-country basis. These forecasts take into consideration social, political, and economic conditions in those countries implementing nuclear power. These forecasts reflect both the near-term and expected long-term impact of the events at the Fukushima Daiichi Nuclear Power Plant in Japan, which were initiated by a massive earthquake and tsunami that struck off the East coast of Honshu, Japan in March 2011 and resulted in the temporary closure of nuclear power plants in Japan and permanent closure of plants in Germany. In addition, the nuclear power forecasts reflect recent and expected early closures of nuclear power plants in the U.S. for economic and other reasons. The Reference forecast for total world nuclear power generation capacity is consistent with a steady average annual nuclear capacity growth rate of 1.8% through 2035, with related growth in nuclear fuel requirements. Growth in the U.S. remains relatively flat through 2035, with the strongest growth expected to take place in China, India, Korea, and Russia.

The nuclear power forecasts, nuclear fuel design, and management parameters for specific types of nuclear power plants are used to project future nuclear fuel material and services requirements. The requirements for each U.S. nuclear power plant now operating or under construction take into account plant specific discharge burn-up, reload fuel assays, fuel cycle lengths, first-core and reload lead times, and operating capacity factors. Generic plant type and country-specific operating and fuel cycle characteristics are used for nuclear power plants outside the U.S., and fuel recycle is included for specific countries in Western Europe, consistent with present and planned activities.

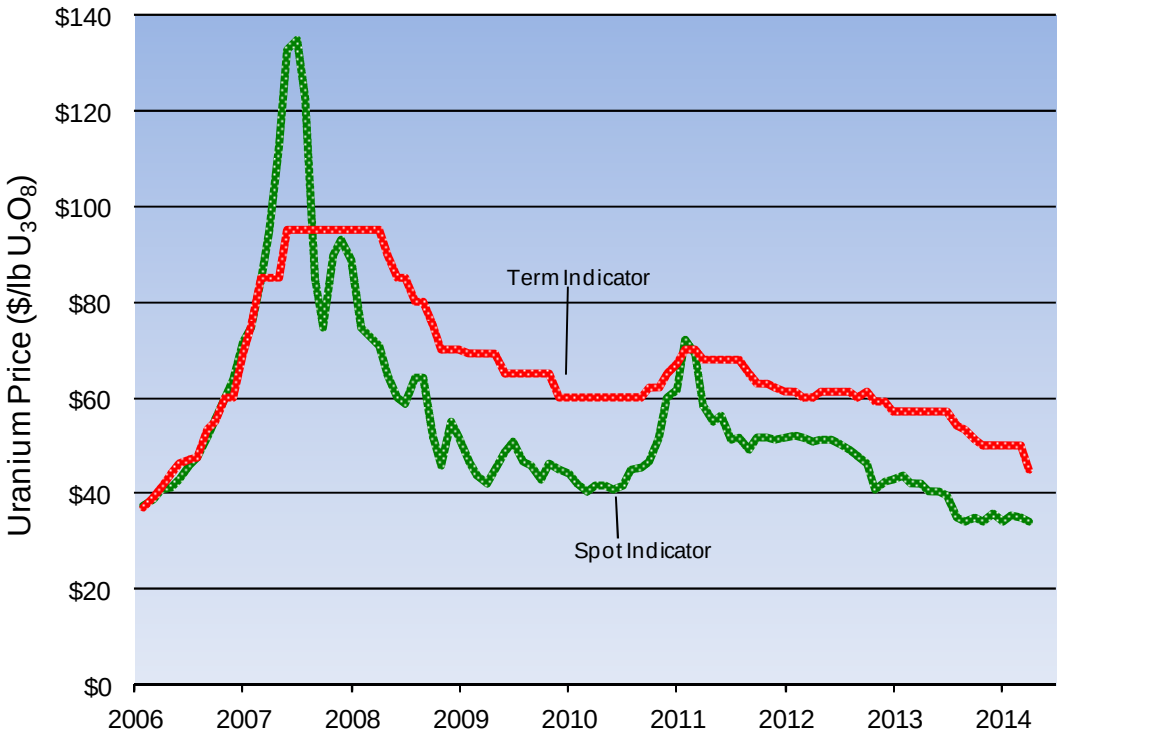
2.1 Uranium Concentrates

2.1.1 Uranium Market Price Activity

The spot market price of uranium was $9.75 per pound U_3O_8 in March 2002 and moved steadily upward, reaching a high of $135 in June 2007, as reported by TradeTech.[4] This 14

[4] TradeTech, LLC (TradeTech) is one of several companies that publish market price indicators for the nuclear fuel industry, and related supply and demand data. Unless otherwise noted, historical and current spot and term market prices for uranium, conversion and enrichment markets that are referred to in this report are based upon information that is published by TradeTech in the April 2014 issue of its monthly publication, The Nuclear Review, and the March 31, 2014 issue of its weekly publication, Nuclear Market

fold increase in price over approximately five years was driven largely by a series of unexpected disruptions to supply, ongoing discussion of a worldwide resurgence in the use of nuclear power, and the entry of financial speculators into the market. The spot price quickly fell back to $85 per pound U_3O_8 by August 2007 and continued to decline, reaching $47 by January 2009. While the rate slowed, the spot price continued in a downward direction, reaching a low of $40.50 per pound U_3O_8 in February 2010. Spot price once again started rising rapidly, rebounding to $72.25 in January 2011 based on renewed enthusiasm for nuclear power's future prospects. The accident at Fukushima Daiichi in March 2011 called nuclear power's prospects into question and the spot price has declined dramatically since that time. The spot price is $34.00 per pound U_3O_8 as of March 31, 2014 as shown in Figure 2.1. This represents a 50% decline from the price level immediately preceding Fukushima and a 35% decline from the price level at the time of the May 2012 Determination.



Source: TradeTech

Figure 2.1 Historical Uranium Spot and Term Market Price Indicators

Review. http://www.uranium.info While ERI utilizes price indicators published by TradeTech in this report, it should be noted that fuel supply contracts that have market related pricing generally reference the TradeTech price indicators as well as price indicators published by UX Consulting (www.uxc.com). While the indices published by these companies are not identical at all times they do closely track one another: for example, over the past two years the spot and term market uranium price indicators differed by 0.5% and 0.2%, respectively. Both provide a reliable measure of the spot and term market prices and are widely quoted. Price indicators published by other companies are not as widely used.

The term (also referred to as long-term) contract price for uranium concentrates rose from $10.40 per pound U_3O_8 in March 2002 to $41 by March 2006 and finally up to $95 per pound U_3O_8 by May 2007. It remained unchanged at $95 through March 2008 and then declined slowly to $65 per pound by May 2009, where it remained through October 2009. In January 2011, the long-term price indicator reached $70 per pound U_3O_8. Following the accident at Fukushima Daiichi, the term price began a steady decline from $68 per pound U_3O_8 in March 2011, to $45 per pound in March 2014 as shown in Figure 2.1. This represents a 35% decline from the price level immediately preceding Fukushima and a 25% decline from the price level at the time of the May 2012 Determination. The term price tends to respond more slowly than the spot price and the changes are less extreme.

The decline in spot market and term market price indicators over the past three years is primarily a reflection of a growing and now considerable over-supply situation. Near-term demand has become highly discretionary and long-term contracting declined dramatically in 2013. While it was initially hoped that reactors in Japan could return to service fairly quickly, it has become clear that it will be a long and drawn-out process, and there is still uncertainty over how many Japanese reactors will ultimately return to service. Until Japanese reactors start returning to service, the fear that sizable Japanese inventories might suddenly be released to the market continues to be a negative influence. Additionally, primary production has continued to grow. The excess supply has led to increased mid-term activity over the past several years, as banks with very low cost financing have bought on the spot market and held the material for resale to end-users.

Despite current low prices, the global uranium supply industry still foresees a bright long-term future driven by increasing requirements for uranium in many parts of the world, led by China. It is uncertain, however, how long it will take the current over-supply to correct through a combination of Japanese reactor restarts, increasing demand elsewhere, a return to normal contracting activity by end-users as well as some additional supply cutbacks and delays in new mine development. As supply and demand come into better balance, prices should rise to the levels needed to develop new supply as needed. Again there is considerable uncertainty as to how long this process will take. If price signals are not received with appropriate lead times, the price rise could be sudden and extreme, perhaps leading to another boom and bust cycle.

2.1.2 Uranium Requirements

As described in the introduction to this Section 2, above ERI's Reference Nuclear Power Growth requirements forecast indicates that world nuclear power plant uranium requirements will increase from the present level of about 160 million pounds U_3O_8 per year to 200 million pounds in 2020, and to about 240 million pounds in 2035. This is an estimated 50% increase over a period of approximately 20 years. At the same time, U.S. requirements are forecast to increase slightly from the present level of 50 million pounds U_3O_8 per year to 51.1 million pounds in 2020 and remaining at an average of 47 million pounds through 2035.

2.1.3 Uranium Supply

The world U_3O_8 supply capacity to meet requirements during the next decades will be obtained from uranium mine production and secondary supply. Secondary supply includes: government and civilian LEU and U_3O_8 equivalent inventories, down blended material from U.S. and Russian government nuclear weapons stockpiles, upgraded enrichment tails, underfeeding by enriched uranium producers, and plutonium and uranium recycle.

ERI estimates that worldwide uranium mine production was 156 million pounds U_3O_8 in 2013 and may increase to 160 million pounds for 2014. Primary production therefore currently is able to fill about 95% of total world nuclear power plant requirements under ERI's Reference Nuclear Power Growth Scenario. Uranium mine production has grown from providing 58% of world uranium requirements in 2000, to 80% in 2010, to more than 90% over the past several years.

ERI presents future uranium supply under two separate scenarios: a Delayed Supply scenario and a Scheduled Supply scenario. Under ERI's Delayed Supply for uranium, which assumes that new uranium supply by planned mines and mines under development are delayed in order to balance with demand in the near- to mid-term, total mine production increases to 170 million pounds by 2020 and to more than 215 million pounds U_3O_8 by the 2030 to 2033 time period, which in combination with secondary supply, could meet all nuclear power plant requirements at that time under this same scenario. The Delayed Supply scenario assumes that only a fraction of identified planned and prospective supply is necessary and actually brought into production. After 2033, additional prospective uranium supply would be required to satisfy requirements. This supply scenario is consistent with an average annual expansion rate in worldwide mine production capacity of about 2% through 2033. In contrast, under ERI's Scheduled Supply scenario, which assumes that producers continue with their recent schedules and do not adjust in order to balance with demand in the near- to mid-term, total mine production would increase more rapidly, to 200 million pounds by 2020, but then converge with the Delayed Supply scenario by the year 2025. Some producers are, in fact, adjusting planned production in the near- and mid-term to adjust to reduced demand. Actual mine supply will be between these two scenarios as some producers may be slower than others in reacting to the current market oversupply situation or may not reduce production at all for other reasons (for example, uranium inventory building in some countries).

Six countries (i.e., Kazakhstan, Canada, Australia, Namibia, Niger and Russia) are expected to provide more than 80% of world mine production during the next 10 years. Uranium production in the U.S. has been increasing over the past five years as shown in Figure 2.2 below. There are currently seven uranium production centers in the United States which are in operation (producing uranium):

Company	**Production Center**
Cameco Resources	Highland/Smith Ranch/North Butte
Cameco Resources	Crow Butte

Energy Fuels, Inc.	White Mesa
Mestena Uranium	Alta Mesa
Uranium Energy Corporation (UEC)	Hobson/Palangana
Uranium One	Willow Creek
Ur-Energy, Inc.	Lost Creek

Three of these operations started production after the start of DOE uranium inventory barters in 2009: Uranium One's Willow Creek began operation in 2010, UEC's Hobson/Palangana began operation in late 2010/early 2011, and Ur-Energy's Lost Creek in 2013. Two additional production centers are expected to start operations in 2014: Uranerz Energy Corporation's Nichols Ranch[5] and Peninsula Energy Limited's Lance Project.

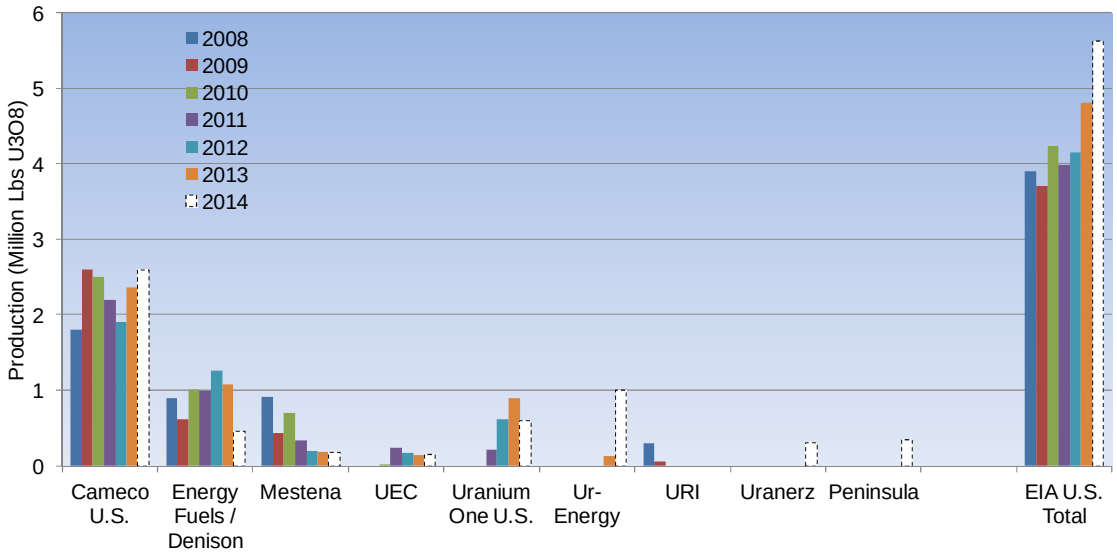


Figure 2.2 U.S. Uranium Production History by Company

Despite the overall increase in U.S. uranium production over the past five years, the decline in prices have impacted the actual and planned production of some U.S. operations. Announced cut backs at existing operations include the following:

- 4Q/2012 Energy Fuels placed its Daneros, Beaver and Pandora mines on standby.
- 2Q/2013 Uranium One announced that it will not develop new well fields at Willow Creek.
- 09/2013 UEC defers further capital expenditures for Palangana production wellfields and reduces operations.
- 11/2013 Energy Fuels - Arizona 1 mine is expected to cease production in early FY-2014 due to the depletion of its known resources. Mining at the Pinenut mine will be put on standby in mid 2014.

[5] Nichols Ranch announced the commencement of uranium mining operations on April 15, 2014.

Total U.S. production in 2013 from these properties, and the White Mesa Mill was reported by DOE's Energy Information Administration (EIA) to have been 4.8 million pounds.[6] U.S. mine production has ranged between 3.7 and 4.8 million pounds annually over the past five years. Production in 2014 is expected to range between 5.0 and 5.7 million pounds, with the uncertainty centered on the two startups. It is expected that U.S. production centers will continue to produce over 5 million pounds annually during each of the next several years, with production increasing as new projects reach planned capacity.

2.1.4 Adequacy of Uranium Supply Relative to Requirements

Figures 2.3 and 2.4 present the projected world uranium supply and requirements relationship for ERI's Reference Nuclear Power Requirements for a Delayed Supply scenario and a Scheduled Supply scenario through 2035, respectively. Both Figure 2.3 and Figure 2.4 show a market that is oversupplied in the near- to mid-term. In Figure 2.3, total supply exceeded requirements by approximately 50 million pounds in 2013. For the Delayed Supply scenario assumed in Figure 2.3, the supply excess could drop to about 30 million pounds in 2014 as the U.S. Russian HEU agreement expired at the end of 2013 and additional supply delays and cutbacks are implemented. During the period 2014 through 2021, the Delayed Supply scenario shows an average of 22 million pounds U_3O_8 in excess of requirements, about half of which could be used to increase utility strategic inventory in support of new reactor capacity. The additions to strategic inventory may be lower, however, as commercial inventories have increased significantly over the past three years. This more balanced relationship between supply and demand is contingent on near-term cutbacks and delayed ramp up of mines that are currently under development. In particular, combined output from the three large mines now in development – Cigar Lake, Husab and Imouraren – must be limited to about a third of current plans over the next five years. They could then be able to ramp up to nominal output capacity shortly after 2020, as shown in Figure 2.3. Planned and prospective uranium supply from already identified mining projects would then be necessary starting in 2023 and steadily growing through 2035.

As shown in Figure 2.4, if mines currently under development proceed according to plan, rather than delay and scale back in recognition of the lack of market need, then a supply excess of approximately 40 million pounds is projected for 2014. Supply could then average 48 million pounds in excess of requirements over the 2015 to 2021 period. Such extreme and long-term over-supply is not sustainable and actual mine supply is expected to be less than shown in Figure 2.4 as producers continue to respond to the current oversupply in the market. Assuming that there are few additional near-term cut backs in supply from mines that are under development, additional new supply capacity would be needed starting around the year 2025 and would come from already identified planned and prospective mining projects, as well as the large inventories produced prior to 2022. The additional

[6] *Domestic Uranium Production Report,* data for 4th Quarter 2013, U.S. Energy Information Administration, January 2014.

planned and prospective supply is not shown in Figure 2.4, as the figure is intended to focus on the considerable over supply which will extend over the next ten years if current development plans are not brought into line with actual market needs.

Figures 2.3 and 2.4 also show secondary supply as HEU and Other Secondary Supply. The Figures show the contribution from the Russian HEU-derived LEU during the period through 2013, after which that source of uranium supply will no longer be present through the U.S.-Russia HEU Agreement.[7] Re-enrichment of tails in Russia and underfeeding by all enrichers is expected to increase. In addition, Other Secondary Supply includes plutonium and uranium recycle in some Western European countries, and that some excess weapons plutonium will be consumed in the U.S. and Russia in the form of mixed oxide (MOX) fuel.

During 2013, utility inventory building continued in many parts of the world, led by China, but also in the US, Europe and Japan as well as at some suppliers. Total inventory building during 2013 is estimated to have been in excess of 50 million pounds, similar to the level of inventory building in 2012. The increase in inventories in Japan, where no nuclear power plants are currently operating due to safety reviews, is likely to result in extending when Japanese utilities may need to purchase uranium in the future. In summary, while the current situation of oversupply of uranium is expected to improve somewhat as secondary supply decreases, discretionary purchases over the past several years for the purpose of inventory building may prolong the soft market for uranium for several more years.

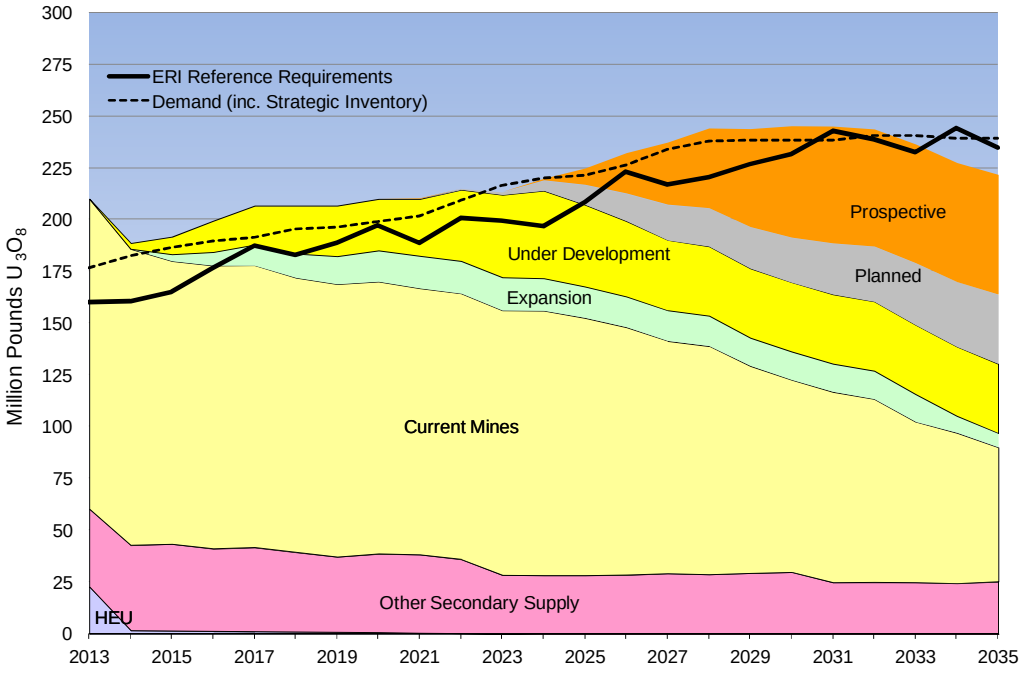


Figure 2.3 Supply Adequacy Assuming Delayed Supply and Reference Requirements

[7] USEC purchases under the Megatons to Megawatts program were completed in December 2013, USEC, Inc., Annual Report, 10-K, For the fiscal year ended December 31, 2013, p. 4.

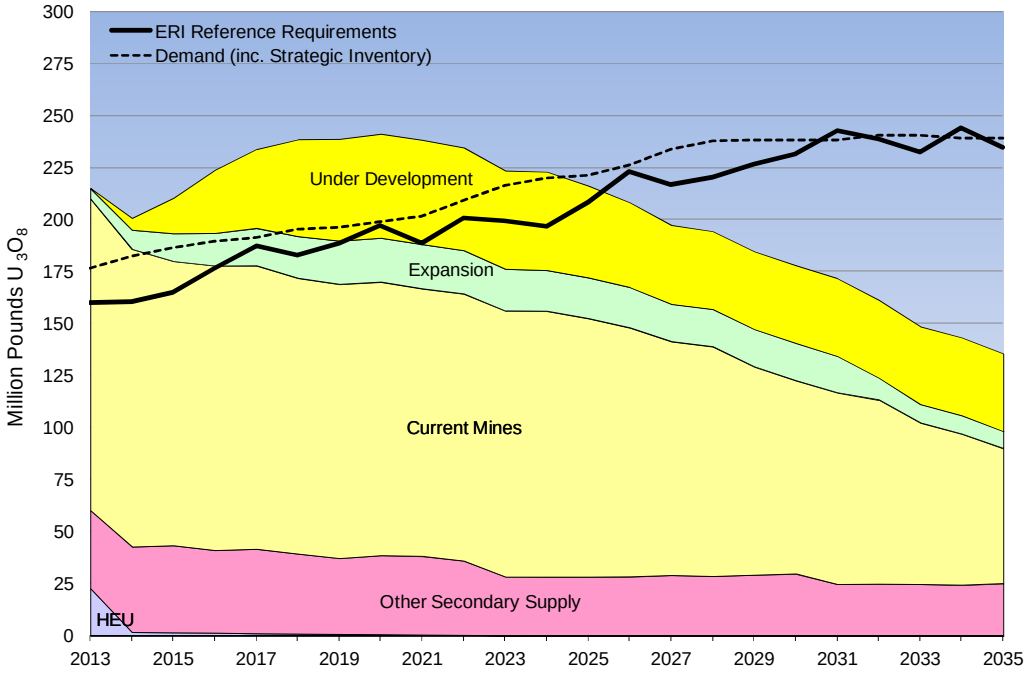


Figure 2.4 Supply Adequacy Assuming Scheduled Supply and Reference Requirements

2.2 Conversion Services

There are four primary suppliers of uranium conversion services worldwide: Converdyn, a partnership of General Atomics Energy Services and Honeywell International, Inc. (Honeywell) in the U.S.; Cameco Corporation (Cameco), which operates facilities in Canada and receives toll conversion services under an agreement with Springfields Fuels Limited (SFL) in the U.K.; Comurhex, an AREVA subsidiary in France; and Joint Stock Company TVEL (TVEL), a subsidiary of Rosatom in Russia. There are also several smaller conversion services suppliers that provide indigenous supply – the largest of which is China National Nuclear Corporation (CNNC) in China.

2.2.1 Conversion Market Price Activity

The North American conversion services spot market price reported by TradeTech was in the range of $11 to $12 per kgU as UF_6 between early 2005 and July. However, in August 2007 the conversion spot market price began to drift downward, reaching a low of $5.00 per kgU in February 2010. The price began to rise in June 2010 and by August 2010 it had reached $13.00 per kgU, and remained in a range of $12.00 to $13.00 through April 2011. Following the accident at Fukushima Daiichi in March 2011, the spot market indicator began to drop in May 2011, reaching $6.75 per kgU in March 2012. Following the announced temporary closure of Honeywell's Metropolis Works in July 2012, the spot market indicator began to rise reaching $10.50 per kgU in October 2012. The price began

to decline again in May 2013, as supplies increased with the return of the Metropolis Works, reaching $7.50 per kgU as of March 31, 2014 as shown in Figure 2.5.

The North American long-term market price indicator ranged between $11.00 and $12.25 per kgU between January 2005 and July 2010. Spurred by Converdyn's 2010 announcement to customers that it was no longer willing to enter into term contracts at prices lower than $15.00, the term price indicator began to slowly increase, reaching $15.00 in November 2010 and $16.75 in September 2011, where it remained until July 2013 when the price indicator fell to $16.00 per kgU. Following the March 2011 accident at Fukushima Daiichi, there was not a subsequent drop in the term conversion price indicator for conversion as was seen with the uranium market price indicator. The term price indicator remains at $16 per kgU as of March 31, 2014. While the term price experienced only a minor decline in 2013, term contracting activity during 2013 declined more significantly.

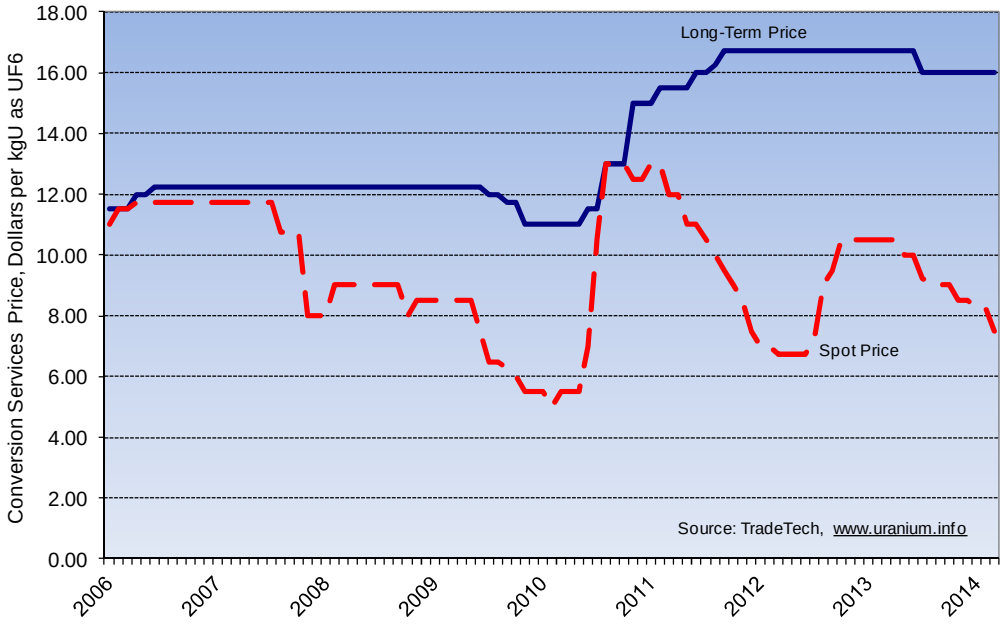


Figure 2.5 North American Spot and Term Market Indicators for Conversion Services, 2006-2014

There is a price differential between conversion services produced at facilities in North America compared to those in Europe that results in two sets of price indicators for conversion services – a North American indicator and a European indicator. The price differential is due to a mismatch between the volumes of UF_6 produced and the volume of UF_6 feed required at enrichment plants on the two continents. The amount of UF_6 produced (assuming nominal capacities) at the conversion facilities in North America

(Metropolis Works and Cameco's Port Hope) is significantly greater than the amount of UF_6 feed needed at U.S. enrichment plants (Urenco USA). In contrast, the amount of UF_6 produced at European conversion facilities (Comurhex II and SFL) is lower than the amount of UF_6 feed needed at European enrichment plants operated by Urenco and AREVA. With the recent announced termination of Cameco's toll conversion agreement with SFL in 2014, there will be even lower UF_6 conversion capacity in Europe in 2015. Thus, some percentage of UF_6 that feeds European enrichment plants must be shipped from North American converters, leading to additional transportation costs for UF_6 produced by North American converters. European converters can take advantage of the additional cost of North American conversion services that are shipped to Europe for enrichment, allowing them to also charge somewhat higher prices for delivery of UF_6 to European enrichment facilities.

2.2.2 Conversion Services Requirements

ERI's Reference Nuclear Power Growth forecast indicates that world nuclear power plant requirements for conversion services will rise from the present level of 60 million kgU as UF_6 per year in 2014 to 68 million kgU in 2020 and 85 million kgU in 2030. At the same time, U.S. requirements are forecast to increase from the current level of 18 million kgU per year to 18.4 million kgU in 2020 and rising only slightly by 2030 to 19.5 million kgU.

2.2.3 Conversion Services Supply

As noted above, there are presently four primary commercial suppliers of uranium conversion services: Converdyn, Cameco, AREVA/Comurhex, and Rosatom/TVEL. Two of these suppliers are located in North America, Converdyn in the U.S. and Cameco in Canada, with a supporting plant, SFL, in the United Kingdom (U.K.). In March 2014, Cameco announced that it would cancel its toll conversion services contract with SFL during 2014 due to current market conditions. AREVA/Comurhex is located in France. Rosatom/TVEL currently operates two facilities that produce UF_6, and UF_4. Rosatom does not typically sell conversion services alone, but has for some years been exporting enriched uranium product (EUP) containing equivalent conversion services to Western Europe, the U.S., and East Asia. CNNC produces conversion services for indigenous requirements in China and there are other small converters that cover indigenous requirements in other countries. Primary conversion production in 2014 of 52 million kgU as UF_6 is expected, which represents about 87% of the estimated 2014 world requirements of 60 million kgU. This indicates a gap between primary production and requirements of 8.0 million kgU.

In addition to primary conversion capacity, secondary supply in the form of commercial UF_6 equivalent (UF_6e) was approximately 23 million kgU in 2013, but this volume of secondary supply is expected to fall to between 15 and 16 million kgU per year during 2014 to 2020, following the conclusion of the U.S.-Russia HEU Agreement in 2013. The conversion component of the HEU-derived LEU, which ended in 2013, was approximately 9 million kgU per year and accounts for most of this decrease. Other components of

secondary supply include the DOE inventories evaluated in this report, underfeeding of enrichment plants by enrichment producers, the upgrade of DUF_6 tails in Russia, and plutonium and uranium recycle. From 2014 through 2020, enricher underfeeding and the upgrade of DUF_6 tails in Russia are the largest components of secondary supply making up approximately 60% of secondary supply.

The Honeywell Metropolis conversion facility in the U.S. has an annual production nameplate capacity of 15 million kgU as UF_6, but the plant has not operated at that level. Maximum sustainable production capability is an estimated 12 million kgU per year when the plant is operating for the entire year. During the extended shutdown of the plant in 2012 and 2013 to implement seismic upgrades required by the U.S. Nuclear Regulatory Commission (NRC), estimated production is estimated to have been less than 5 million kgU annually.

Cameco's Port Hope, Ontario conversion capacity is expected to maintain an annual conversion capacity of about 10 million kgU for the foreseeable future. However, Westinghouse' SFL conversion facility in the U.K. will close in 2014 with Cameco's early cancellation of its toll conversion services agreement with SFL in 2014. Production at SFL in 2014 is expected to be 3.7 million kgU.[8]

AREVA began construction of new Comurhex II conversion facilities as Malvesi and Pierrelatte in 2009. The facilities will have an annual production of 15 million kgU when full production is reached, with the ability to expand production capacity to 21 million kgU. Comurhex II is expected to begin operation in 2015.

Rosatom subsidiary TVEL is currently responsible for production of UF_4 and UF_6 at two facilities: the Siberian Chemical Combine (SCC) produces UF_6; and JSC Chepetsk Mechanical Plant (CMP) produces UF_4. Joint Stock Company (JSC) Angarsk Electrolysis Chemical and Combine (AECC), which produced UF_6, was closed at the end of the first quarter of 2014. Nameplate capacity for UF_6 production at SCC is 8 million kgU per year. TVEL is in the process of modernizing and consolidating its conversion production capability with construction of a conversion production center at SCC. According to recent reports, the first stage of the facility will have an annual capacity of 18 million kgU of UF_6 per year, with the possibility of expansion up to 20 million kgU per year. However, the original facility commissioning that was expected in 2016 has been delayed by several years due to market conditions.

2.2.4 Adequacy of Conversion Supply Relative to Requirements

Figure 2.6 shows projected supply of UF_6, including primary production and secondary supply, compared to conversion requirements. Supply reflects recent and expected conversion facility closures in the U.K. and Russia and the transition to new conversion

[8] Cameco Corporation, *Cameco ends toll-conversion agreement with Springfields Fuels Ltd.*, Press Release, March 31, 2014.

facilities in France and Russia in the future. ERI's assumptions regarding new facilities and expansion of existing facilities are consistent with recent announcements associated with these facilities and in some cases the behavior of various governments in their ongoing development of nuclear power and supporting fuel supply services, and also with the expected use of commercial and government inventories. Components of other secondary supply include: DOE inventories evaluated in this report, enricher underfeeding, the upgrade of DUF_6 tails in Russia, and plutonium and uranium recycle. From 2014 through 2020, enricher underfeeding and the upgrade of DUF_6 tails in Russia are the largest components of secondary supply making up approximately 60% of secondary supply. It is important to note that Chinese conversion capacity is expected keep pace with increasing requirements for conversion services as nuclear power capacity grows rapidly in that country.

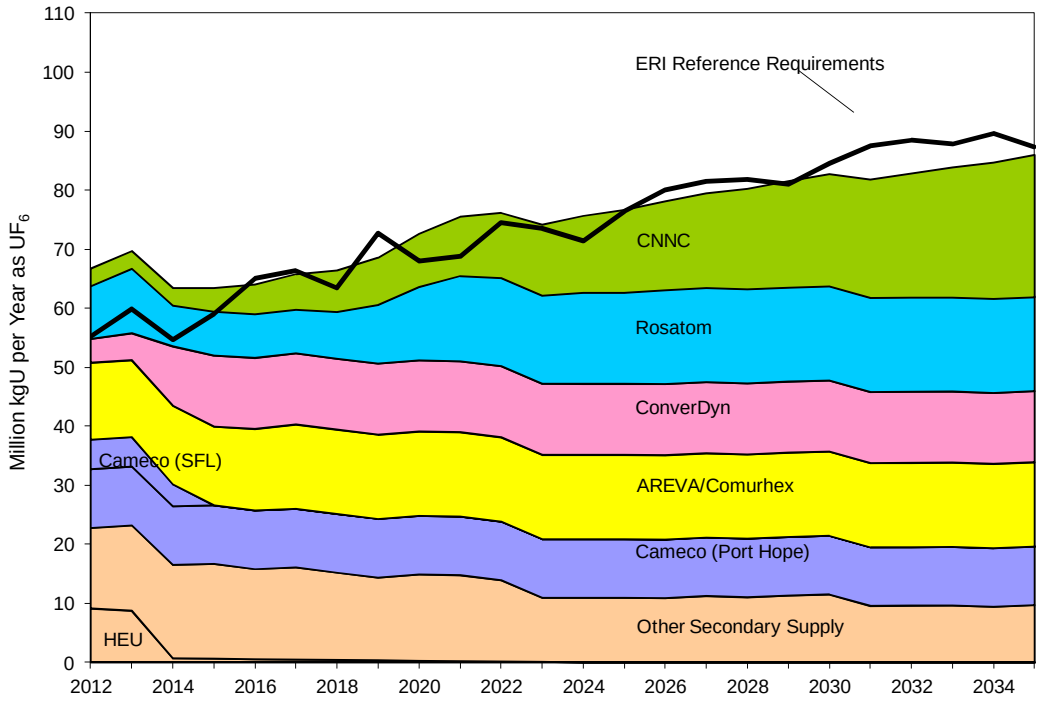


Figure 2.6 Forecast of World Supply and Requirements for Conversion Services

While removal of production capacity associated with the SFL plant in the U.K and Rosatom/TVEL's AECC facility in Russia results in an apparent supply-demand balance beginning in the 2016-2017 time period, existing market overhang of UF_6 associated with large utility and supplier inventories may impact conversion requirements in some regions for several years after that, depending upon when and how many Japanese reactors restart operation.

The balance between supply and demand during the period from 2019 forward indicates that requirements for conversion services will exceed total supply by a small amount. A limited amount of additional conversion capacity will then need to be brought into operation or planned facility expansions such as the additional capacity at Comurhex II

could be brought into service. The lead time for a new plant is expected to be three to five years; while the lead time for expansion of an existing plant could be at the lower end of this range.

While there is an eventual need for limited expansion of existing supply in order to meet the Reference Nuclear Power Growth forecast requirements for conversion services, in the near term, the oversupply situation has resulted in Cameco's early termination of its toll conversion services agreement with SFL and closure of Rosatom/TVEL's AECC conversion plant in Russia. As previously noted, several primary suppliers have already taken initial steps to make upgrades to existing facility or to replace aging facilities. However, new facility development plans in Russia have been delayed due to current market conditions and expansion of Comurhex II above its initial capacity will only occur if market conditions warrant.

2.3 Enrichment Services

There are four active primary suppliers of enrichment services and EUP that include AREVA in France; Rosatom in Russia; Urenco Limited (Urenco) with enrichment facilities in the Netherlands, Germany, the U.K, and the U.S.; and USEC Inc. which is based in the U.S. and has contracts to provide enrichment services and EUP, but no longer produces enriched uranium. Regional suppliers include China Nuclear Energy Industry Corporation (CNEIC), Japan Nuclear Fuel Limited (JNFL) and others. In addition, a proposed new supplier of enrichment services is Global Laser Enrichment (GLE), which received a license from the U.S. NRC in 2012 for construction and operation of a laser enrichment facility in the U.S.

2.3.1 Enrichment Market Price Activity

The long-term price indicator for enrichment services, as reported by TradeTech, reached a high of $165 per separative work unit (SWU) in May 2009. However, by early 2010 the price began a steady decline, reaching $135 per SWU in October 2012, and further declining during 2013 to the present price of $99 per SWU in March 2014 as shown in Figure 2.7.

While more than 90% of enrichment requirements are covered under long-term contracts, enrichment services and EUP are also traded on the spot market although in lower volumes than uranium. Enrichment spot market indicators, as reported by TradeTech, rose to a high of $165 per SWU in May 2009, but began a slow decline similar to that for the long-term SWU price indicator as shown in Figure 2.7. The spot market indicator declined to $96 per SWU as of March 31, 2014.

As shown in Figure 2.7, the price increases that occurred through mid-2009 were the result of a number of factors, which included the realization that the enrichment market supply and requirements relationship was very tight at that time, requiring that significant new supply be

brought into operation. In addition, rapidly increasing uranium prices led to lower enrichment tails assays as buyers substituted enrichment services for natural uranium, which also increased world requirements for enrichment services. The decline in SWU price indicators that began in 2011 is the result of reduced demand for enrichment services following the Fukushima accident and subsequent increases in supplier and utility inventories. The price decline in the past three years following Fukushima has been considerable: –37% in the term market and –38% in the spot market. Most of the price decline has taken place during the two years following the May 2012 determination, with the term at -32% and the spot at -30%.

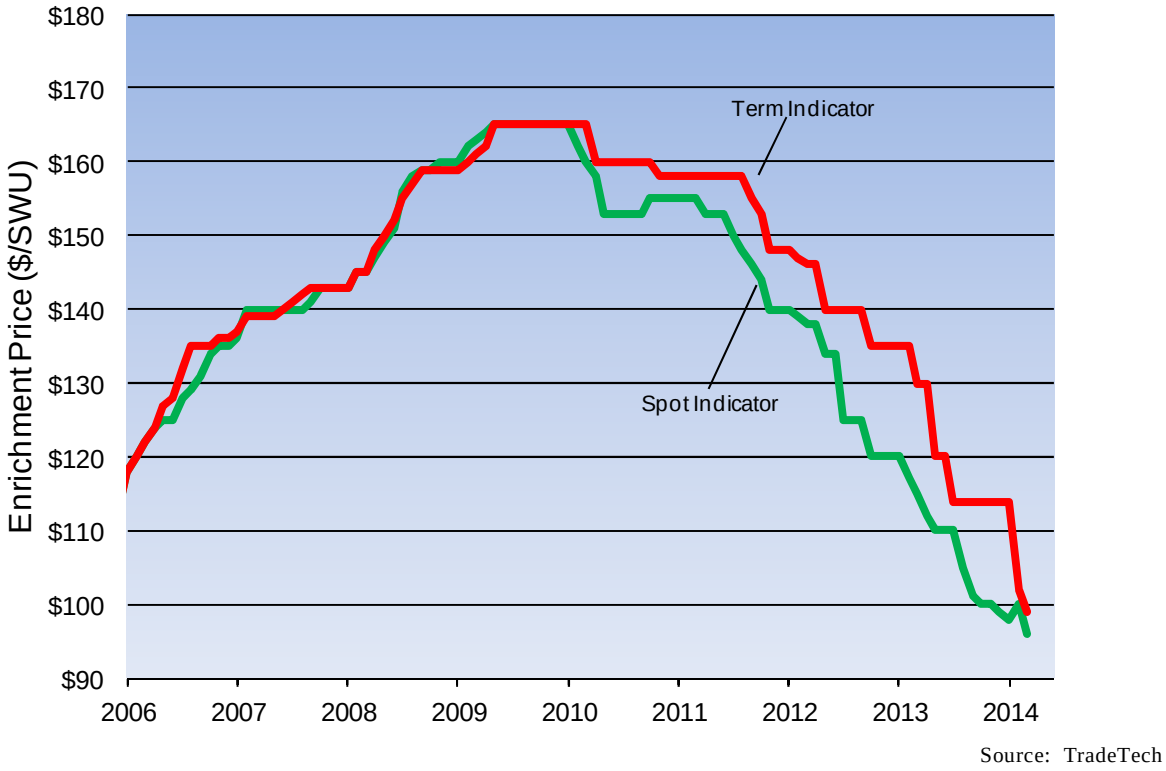


Figure 2.7 Spot and Long-Term SWU Market Price Indicators, 2006-2014

2.3.2 Enrichment Services Requirements

ERI's Reference Nuclear Power Growth requirements forecast indicates world requirements for enrichment services will increase from the present level of about 42 million SWU per year in 2014 to 55.9 million SWU in 2020, and 70.2 million in 2030. At the same time, U.S. requirements are forecast to increase slightly from the present level of 14 million SWU per year to 15.3 million SWU per year in 2020 and 15.6 in 2030. A significant portion of the projected increase in requirements takes place in China, but China is expected to increase its indigenous enrichment capacity accordingly and thereby remain self sufficient.

2.3.3 Enrichment Services Supply

As noted above, there are four primary commercial suppliers of enrichment services and EUP that include AREVA, Rosatom, Urenco and USEC. Two of these suppliers are located in the U.S. – USEC and Urenco. Additional enrichment supply is covered by LEU derived from down blended U.S. and Russian HEU, supplier inventories, and recycle of plutonium as mixed-oxide (MOX) fuel.

USEC, which operated the Paducah GDP in Paducah, Kentucky, until its closure in 2013, is headquartered in Maryland. USEC is currently in voluntary bankruptcy proceedings and hopes to emerge with reduced debt. USEC received a license from the U.S. NRC to build and operate a gas-centrifuge enrichment facility, the American Centrifuge Project (ACP) in Portsmouth, Ohio. USEC has stated that based on the current market situation, commercialization of the ACP is not economically viable at this time. In addition, completion of the ACP depended on USEC's ability to obtain more than $4 billion in needed funding. In early April 2014, DOE announced that it was examining its alternatives for preservation of the centrifuge technology and was exercising its right to take over management of the ACP research, development and demonstration (RD&D) program that was managed by USEC. DOE's interest in the ACP technology revolves around national security concerns, the availability of U.S. enrichment technology and the preservation of intellectual property. USEC served as the U.S. executive agent under the Megatons to Megawatts program in which Russian HEU was down blended to LEU, which USEC sold to electric utilities in the U.S. and other countries. The final transfer of LEU to USEC took place in late 2013.[9] In the near-term, USEC expects that its business will contract from sales of 10 to 12 million SWU annually to an estimated 30% of that volume. Future USEC sales will come from inventory, SWU purchased from other suppliers, and SWU purchased under a Transitional Supply Agreement between USEC and Techsnabexport (TENEX) of Russia, which is a multi-year contract extending through 2022.[10]

Urenco is a multi-national company with three shareholding companies: Enrichment Holdings Limited of the U.K., Ultra-Centrifuge Nederlands N.V. (UCN) of the Netherlands, and Uranit GmbH of Germany. In the U.S., Urenco Limited is represented by Urenco USA Inc., a wholly-owned subsidiary established in 1984. Urenco USA's subsidiary Louisiana Energy Services, LLC (LES) is the operator of the Urenco USA enrichment facility in New Mexico. The Urenco USA enrichment facility has a current annual capacity of 3.7 million SWU. Further expansion has been slowed due to market conditions, however. Urenco USA will reach 4.7 million SWU in 2015, followed by a very gradual increase to 5.7 million SWU by 2023. Urenco SWU deliveries from all of its facilities totaled 13.8 million SWU in 2013. Urenco's share of the World market is 31%. Urenco's 2013 enrichment deliveries as a percent of its total deliveries by region are 40% to the U.S., 44% to Europe, and 14% to Asia, with the balance of 2% to the rest of the world. Deliveries to U.S. customers originate from both the Urenco USA plant as well as the European production base.[11]

[9] USEC, Inc., Annual Report, 10-K, For the fiscal year ended December 31, 2013, p. 4.

[10] Ibid.

[11] Urenco, Limited, Annual Report and Accounts 2013, http://www.urenco.com/page/69/Publications.aspx.

It should be noted that AREVA has received a NRC license and a DOE loan guarantee for a new centrifuge enrichment plant – the Eagle Rock Enrichment Facility. Development plans are officially on hold, but the EREF is viewed as unlikely to proceed for many years if at all. The AREVA and Urenco jointly-owned subsidiary Enrichment Technology Company is in the process of severely scaling back its centrifuge manufacturing operations due to lack of demand for new centrifuges. ETC's knowledge base and basic capabilities will be maintained, but it will take many years to ramp back up its manufacturing capabilities if warranted by market need.

Under ERI's Reference Supply for enrichment services, total enrichment supply in 2014 is expected to be 50 million SWU in 2014 and to increase to 60 million SWU by 2020. By 2030, enrichment supply will increase to 72 million SWU per year, as shown in Figure 2.8. Supply from sources other than primary production is an estimated 6 million SWU in 2014 and will be less than 3 million SWU per year during the period 2016 to 2030. The decline is driven primarily by completion of the U.S./Russian HEU Agreement, where the last shipment arrived in the U.S. in December 2013. The use of supplier inventories built up to ease the transition away from gaseous diffusion technology declines as well. The Reference Supply includes the expansion of AREVA's GBII centrifuge enrichment plant to 7.5 million SWU and the Urenco USA plant to 5.7 million SWU. Enrichment capacity in China is also assumed to expand to keep pace with that country's growing requirements. The Reference Supply does not include new enrichment plants proposed by AREVA (Eagle Rock), USEC (ACP) or GLE (Silex at Castle Hayne).

2.3.4 Adequacy of Enrichment Supply Relative to Requirements

Figure 2.8 presents ERI's forecast of uranium enrichment supply, discussed above, and the ERI Reference Nuclear Power Growth requirements through 2035. As shown in the figure, total world enrichment supply significantly exceeds projected requirements, which are calculated on a 0.22 weight-percent U^{235} tails assay basis over the long term. In addition to primary supply, Figure 2.8 shows the contribution from the Russian HEU-derived LEU during the period through 2013, commercial inventory releases and the contribution from recycle. This figure demonstrates the lack of balance between enrichment supply and demand which currently exists prior to enricher underfeeding (operating at tails assays than lower than customer specified transaction tails) to absorb the excess capacity.

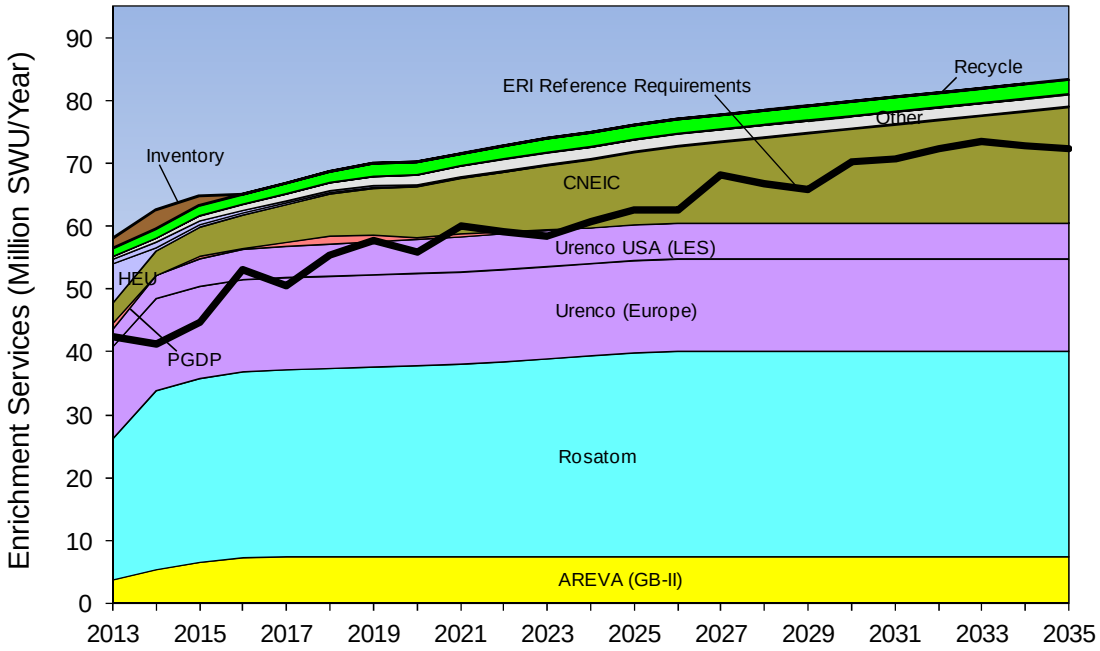


Figure 2.8 Forecast of World Supply and Requirements for Enrichment Services

In 2014 and 2015, base supply is greater than requirements by an estimated 20 million SWU per year and supply is expected to exceed requirements from 2016 through 2030 by an estimated 13 million SWU per year. The excess supply will continue to be devoted to underfeeding. Primary production is now entirely based on centrifuge technology, which is designed to operate continuously. As a result, enrichment suppliers are now devoting the excess enrichment capacity shown in Figure 2.8 to underfeeding. Significant underfeeding and re-enrichment of DUF_6 has taken place in Russia for many years due to lack of available markets for its substantial enrichment capacity. USEC historically used excess GDP capacity to underfeed. The other enrichers are now faced with excess capacity and have started underfeeding as well. Even after taking into account known enricher underfeeding plans, supply margin during 2014-2015 will remain high.

In summary, the enrichment market is expected to be in oversupply through mid-term and perhaps longer. Suppliers may allow existing capacity to decline by not replacing centrifuge cascades as they are retired from service, but centrifuges typically have lifetimes of 20 years or more, so any reduction will be gradual. The excess supply will therefore continue to be utilized by enrichment suppliers for uranium production via underfeeding, which will allow secondary supply in the uranium and conversion markets to remain substantial even though the HEU Agreement has ended.

As with the uranium and conversion markets, the excess enrichment services supply is the result of reduced worldwide demand and subsequent increase in inventories of EUP following the accident at Fukushima in 2011. Since excess capacity is expected to continue for the foreseeable future, enrichers will continue to utilize the excess capacity for underfeeding allowing further sales of LEU or even natural UF_6.

2.4 Summary of U.S. Requirements for Nuclear Fuel

Figure 2.9 provides a summary of U.S. requirements for nuclear fuel materials and services over the period 2014 through 2035 that is based upon ERI's current Reference Nuclear Power Growth forecasts. The saw tooth nature of these annual requirements reflects that, with only a few exceptions, U.S. nuclear power plants that operate on 18 or 24 month refueling cycles.

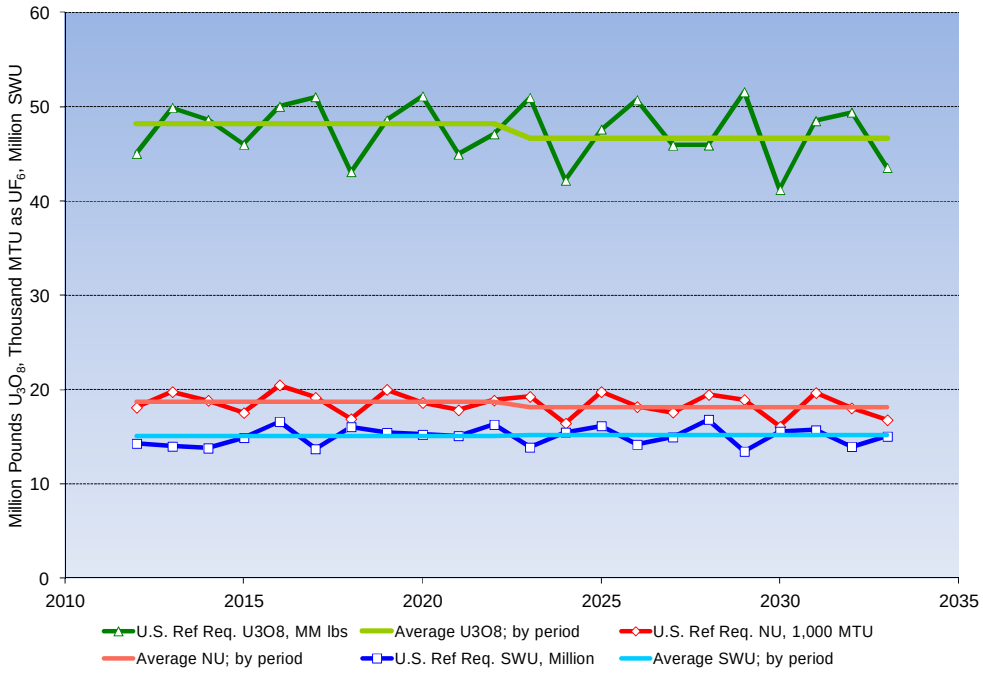


Figure 2.9 U.S. Requirements for Nuclear Fuel Materials and Services

Since the underlying change in average U.S. requirements over time is relatively small, but with significant year-to-year variation, average values that represent forecast years (i) 2014 through 2023 and (ii) 2024 through 2033, as presented in Table 2.1. These values may be used to provide perspective regarding the quantities of DOE material released to the global commercial markets relative to U.S. requirements.

	Average Over Period 2014 - 2023	Average Over Period 2024 – 2033
U.S. Uranium Concentrates Requirements Million Pounds U_3O_8	48.2	46.7
U.S. Uranium Conversion Requirements Million MTU of U as UF_6	18.8	18.1
U.S. Enrichment Services Requirements Million SWU	15.1	15.1

Note: 1,000 MTU = 1 million kgU
Source: ERI 2013 Nuclear Fuel Cycle Supply and Price Report, Update, Reference Nuclear Power Growth Forecast

Table 2.1 Summary of U.S. Requirements for Nuclear Fuel Materials and Services

As a point of comparison, the ERI requirements forecast shown in Table 2.1 is in general agreement with, but more conservative than the most recent analysis by the World Nuclear Association (WNA), which was published in September 2013 and is entitled "The Global Nuclear Fuel Market: Supply and Demand 2013-2030" (WNA 2013). WNA 2013 also provides projected U.S. requirements for nuclear fuel materials and services. Over the 2014 through 2030 period, the total U.S. nuclear fuel requirements forecasts published by WNA are 5% to 7% higher than those shown in Table 2.1.

2.5 Summary of Published Market Prices

Current monthly spot and term market prices[12] (also referred to as "price indicators") are summarized in Table 2.2.

	Spot Market Price	Long-Term Market Price
Uranium Concentrates $/lb U_3O_8	$34.00	$45.00
Uranium Conversion Services (North American) $/kgU as UF_6	$7.50	$16.00
Enrichment Services $/SWU	$96.00	$99.00
Uranium as Natural UF_6 $/kgU as UF_6	$96.00	$134.00

Market Price Indicators are as published by TradeTech in the March 31, 2014 issues of its weekly publication, Nuclear Market Review. www.uranium.info

Table 2.2 Recently Published Market Prices

[12] TradeTech's spot prices "reflect the company's judgment of the price at which spot and near-term transactions for significant quantities [of that product or service] could be concluded as of the last day of the month". TradeTech's long-term price indicators are "TradeTech's judgment of the base price at which transactions for long-term delivery of that product or service could be concluded as of the last day of the month, for transaction in which the price at the time of delivery would be an escalation of the base price from a previous point in time." While ERI utilizes price indicators published by TradeTech in this report, it should be noted that fuel supply contracts that have market related pricing generally reference the TradeTech price indicators as well as price indicators published by UX Consulting (www.uxc.com). While the indices published by these companies are not identical at all times they do closely track one another: for example, over the past two years the spot and term market uranium price indicators differed by 0.5% and 0.2%, respectively. Both provide a reliable measure of the spot and term market prices and are widely quoted. Price indicators published by other companies are not as widely used.

3. DOE Inventory Expected to Enter the Commercial Markets

There are three broad categories of material for which DOE inventory is expected to enter the commercial markets during the period of time that is addressed by this analysis (2014 through 2033). They are (i) historical DOE transfers that will continue to displace commercial supply in the market in the future, (ii) ongoing inventory transfers in exchange for services (barters), and (iii) proposed transfers of DOE inventory, including additional DUF_6, off-spec LEU, and a limited amount of off-spec non-UF_6 that are currently under negotiation with selected companies, as a result of earlier DOE RFOs. Each is addressed separately and then they are combined for further evaluation.

3.1 Historical DOE Transfers That Continue to Displace Commercial Supply

DOE has transferred inventories in the past, some of which will continue to displace commercial supply in the market in the future, even though the transfers are completed. The historical transfers include off-spec HEU to the TVA and high assay DUF_6 to ENW. In each case, the transferred DOE inventories were processed (down blended or re-enriched) and the resulting LEU product loaded into company reactors over a period of many years. For purposes of evaluating the impact of the transferred inventories on the commercial markets and U.S. industry, it is appropriate to evaluate the impact according to the schedule of the delivery of the processed inventory as reactor fuel, rather than the initial transfer schedule of the unprocessed inventory.

Off-Spec HEU to TVA

TVA has been blending off-spec HEU since 2005 under the BLEU program. [13] A total of 46 MT of HEU has been processed. The transfer to and down blending of the off-spec LEU by TVA's down blending contractors was completed in 2012. The first BLEU reload was introduced into a TVA reactor in 2005. BLEU reloads continue to be loaded into the Browns Ferry reactors, with the final BLEU reload scheduled for 2016.

ERI believes that any potential market impact of the DOE transfers to TVA would be most appropriately viewed as occurring during the year prior to such materials being loaded in the TVA nuclear power plants. This is consistent with a 12 month lead time prior to the start of a refueling outage for the delivery of uranium concentrates. The displacement of commercial supply in the market associated with the enrichment services component of the BLEU reloads is assumed to take place 6 months prior to the refueling outage.

[13] This is a long-term contract between DOE and TVA under which the first fuel assemblies that contained the NNSA off-spec material were loaded into a TVA nuclear power plant in March 2005.

DOE Depleted UF_6 Transferred to ENW and Subsequent ENW LEU Sale to TVA

DOE transferred 9,075[14] MTU of high assay DUF_6 to ENW in 2012 and early 2013. The DUF_6 was then enriched to LEU by ENW, with enrichment services provided under a contract with USEC. The enrichment took place between June 2012 and May 2013 at the Paducah GDP. The resulting 482 MT-LEU contains the equivalent of approximately 4,300 MTU of natural uranium (11 million pounds U_3O_8 equivalent) and 3.2 million SWU.[15] ENW entered into a contract with TVA for the purchase by TVA of most of the enrichment content of the LEU as well as a significant portion of the uranium content. The enrichment services and natural uranium equivalent are to be delivered to TVA between 2015 and 2022. TVA will use the delivered materials to support tritium production on behalf of DOE. The remaining natural uranium equivalent, and a small portion of the enrichment services, will be used by ENW between 2018 and 2029 to meet reload requirements for the Columbia Generating Station, with all electricity output going to the Bonneville Power Administration. As indicated by the above discussion, while the DUF_6 was transferred in 2012, the NU content of the resulting LEU will not displace commercial supply in the market until the 2018 to 2029 time frame [enrichment services 2015 to 2023], when it is actually used by TVA and ENW. The DUF_6 had no intrinsic enrichment content, rather it generated new demand for enrichment services. Approximately 1.2 million SWU were required to enrich the DUF_6 to natural assay (0.711 w/o), out of a total of 4.4 million SWU contracted with USEC to enrich the DUF_6 to the LEU's final product assay (4.4 w/o). The 3.2 million SWU equivalent content of the LEU represents a shift in the timing of enrichment services supply. The enrichment services provided by USEC in 2012 and 2013 is effectively stored in the LEU inventory for use in the years 2015 to 2023, when enrichment services would have occurred absent the DUF_6 transfer agreement between ENW and DOE.

The natural uranium and enrichment services content of the LEU created from the DUF_6 is being delivered under long-term contracts.

Summary of Historical DOE Transfers That Continue to Displace Commercial Supply

Table 3.1 presents a summary of the year and quantities of natural uranium as UF_6, equivalent uranium concentrates, and enrichment services that are assumed for the historical DOE transfers that will continue to displace commercial supply in 2014 through 2029.

[14] DOE's July 2013 Excess Uranium Inventory Management Plan indicates 9.082 MTU of high assay DUF_6 while ENW's Fuel Management Plan specifies 9,075 MTU. ENW delivered 600 MTU of natural UF_6 to USEC along with the DUF_6.

[15] ENW's FY2014 Fuel Management Plan and information provided by DOE in 2012.
ENW FY2014 Fuel Management Plan was found at: http://www.bpa.gov/news/FOIA/2013/13-01495/BPA-2013-01495-FResponse.pdf.

Year	MTU as UF_6			Equivalent Million Pounds of U_3O_8 (a)			Equivalent SWU (Millions)		
	TVA BLEU	ENW DUF_6	Total	TVA BLEU	ENW DUF_6	Total	TVA BLEU	ENW DUF_6	Total
2012	318		318	0.8		0.8	0.7	0.0	0.7
2013	627		627	1.6		1.6	0.3	0.0	0.3
2014	318		318	0.8		0.8	0.7		0.7
2015	318		318	0.8		0.8	0.3	0.4	0.8
2016	105		105	0.3		0.3	0.1	0.2	0.3
2017								0.2	0.2
2018		624	624		1.6	1.6		0.2	0.2
2019		1,432	1,432		3.7	3.7		0.8	0.8
2020								0.2	0.2
2021		381	381		1.0	1.0		0.7	0.7
2022								0.4	0.4
2023		381	381		1.0	1.0		0.3	0.3
2024									
2025		381	381		1.0	1.0			
2026									
2027		381	381		1.0	1.0			
2028									
2029		158	158		0.4	0.4			
Total 2014-29	741	3,738	4,479	1.9	9.8	11.7	1.1	3.2	4.3

(a) Calculated by multiplying the MTU as UF6 value by a conversion factor of 0.00261285.

Table 3.1 Historical Transfers That Continue to Displace Commercial Supply

3.2 Ongoing DOE Inventory Transfers in Exchange for Services

NNSA Barters

The down blending of DOE HEU is performed by a NNSA contractor, which receives a portion of the 4.95 w/o LEU created from the HEU down blending as barter in lieu of payment for its services. This material received by the NNSA contractor subsequently enters the commercial markets. In addition, in order to perform the down blending of the HEU, diluent in the form of natural uranium is purchased from the commercial market. The diluent provides approximately 10% of the equivalent uranium content in the 4.95 w/o LEU.

The HEU has been down blended to support several programs including the American Assured Fuel Supply (AAFS) inventory and the MOX LEU Backup Inventory Project. According to DOE/NNSA, the final transfer of HEU to the contractor for down blending for the AAFS program took place in 2012. The final transfer to the MOX Backup Inventory Project down blending contractor is expected to take place in 2015. NNSA expects to continue down blending additional HEU through the year 2022, as shown in Table 3.2, although the specific program to which the down blended LEU will be allocated has not been identified by DOE to ERI at present.

It should be noted that the NNSA quantities identified and evaluated in this report do not include transfers of LEU that have a high assay (or enrichment) of uranium isotope 235 (U^{235}) – i.e., 19.75 weight percent U^{235} – derived from HEU to make fuel for research and isotope production reactors. Because the commercial sector cannot produce uranium of that assay, these transfers do not displace commercial activity and have no effect on the domestic nuclear fuel industry.

The NNSA barters are used to fund the HEU down blending activities by transferring a portion of the LEU created in the down blending process. The market value of the 4.95 w/o LEU product has declined over the past two years, and as a result, a larger portion (quantity) of the LEU must be bartered in order to pay for the down blending services. NNSA now anticipates that the NU equivalent of the bartered LEU could total as much as 650 MTU per year, which is higher than the previous estimate of 400 MTU per year (DOE 2013 Plan). However, DOE plans to offset the higher rate of NNSA barters by lowering the rate of EM barters, which are discussed below.

EM Barters

DOE EM is presently making quarterly transfers of natural UF_6 to its contractor, FBP, for services being provided to DOE in support of the environmental cleanup of the Portsmouth GDP. The EM barters totaled 1,601 MTU in 2012 and 2,400 MTU in 2013. The barters [that is, transfers] are expected to continue until DOE inventories of Russian and U.S. origin UF_6 are exhausted. The May 2012 Determination indicated that the total quantity of material expected for EM and NNSA barters was 2,800 MTU per year, which included 2,400 MTU per year for EM barters through 2021 and an additional 400 MTU per year transferred to NNSA contractors through 2020. The DOE 2013 Plan estimated that the quantity of equivalent UF_6 associated with these combined EM and NNSA barters would be 2,705 kgU, which included an estimated 2,320 to 2,330 kgU for EM barters, with the remaining 375 to 385 kgU going to NNSA barters. As discussed previously, the NNSA barters used to fund HEU down blending activities are expected to increase as a result of lower market prices for the 4.95 w/o LEU product. NNSA now anticipates that the NU equivalent of the bartered LEU could total as much as 650 MTU per year, but DOE plans to limit the total NU equivalent in the EM and NNSA barters to 2,705 MTU per year. As a result, the EM barters will decrease and be limited to 2,055 MTU per year if the NNSA barters reach 650 MTU. If the NNSA barters required to pay for the HEU down blending services are less than 650 MTU (e.g. 400 MTU), then a greater quantity of EM barters will take place (e.g. 2,305 MTU), keeping the combined total to 2,705 MTU.

In May 2011, Traxys North America LLC (Traxys)[16] announced that it had entered into an agreement for the purchase of all natural UF_6 through 2013 that the DOE contractor, FBP, expected to receive from DOE under the arrangement referred to in Section 1. That agreement was extended and Traxys continues to be responsible for introducing all EM barter material into the commercial market. The Traxys announcement noted that *"FBP moved away from the*

[16] Traxys is a major participant in the financing, marketing, distribution and financial services for the global mining, metals and minerals industries. In 2013 Traxys purchased 16.5 million pounds of U_3O_8, including 6.3 million pounds from the EM barters, and delivered 15.0 million pounds to customers.

previous practice of spot market auctions…wishing to avoid any impact upon the market", a strategy which has been reiterated by Traxys. Traxys has indicated that it is introducing this material into the commercial markets through an equal mix (by volume of material) of spot market (50%) and term (50%) market transactions.[17] Traxys has also stated that its deliveries of EM barter material are evenly divided between U.S. and non-U.S. customers. Traxys goes on to note that some U_3O_8 and conversion contained in the EM barter material has been contracted separately. As a large and established metals trader, Traxys is able to warehouse the EM barter material as needed in order to ensure its efficient introduction into the commercial markets. Since the EM barter material represents only a fraction of the Traxys supply, it appears to have an incentive to minimize any impacts the material has on the commercial market.

Total EM and NNSA Barters

The material transfers to DOE contractors as payment for services which are presently under consideration by DOE, are summarized in Table 3.2. In addition to showing the annual and total equivalent net amounts of uranium as natural UF_6, which is also the quantity of equivalent conversion services, the corresponding equivalent net amount of uranium concentrates is shown, as is the net equivalent amount of enrichment services.[18]

Year	MTU as UF_6			Equivalent Million Pounds of U_3O_8 (a)			SWU (Millions) (b)
	EM Barters	NNSA Barters	Total	EM Barters	NNSA Barters	Total	NNSA Barters
2012	1,601	176	1,777	4.2	0.5	4.6	0.3
2013	2,400	459	2,859	6.3	1.2	7.5	0.5
2014	2,055	650	2,705	5.4	1.7	7.1	0.6
2015	2,055	650	2,705	5.4	1.7	7.1	0.6
2016	2,053	650	2,703	5.4	1.7	7.1	0.6
2017	2,055	650	2,705	5.4	1.7	7.1	0.6
2018	2,055	650	2,705	5.4	1.7	7.1	0.6
2019	673	650	1,323	1.8	1.7	3.5	0.6
2020		650	650		1.7	1.7	0.6
2021		650	650		1.7	1.7	0.6
2022		271	271		0.7	0.7	0.3
2023							
Total 2014-23	10,946	5,471	16,417	28.6	14.3	42.9	5.1

(a) Calculated by multiplying the MTU as UF6 value by a conversion factor of 0.00261285.
(b) NNSA barters are in the form of 4.95 w/o EUP and therefore have enrichment content.

Table 3.2 DOE Inventory Transfers in Exchange for Services (Barters)

[17] Smith, Kevin, Director Uranium Trading and Marketing, Traxys, Commercial View of DOE's 2013 Plan for Natural Uranium Barter Sales, Nuclear Energy Institute, International Uranium Fuel Seminar, October 6-9, 2013, San Antonio, Texas.

[18] These are referred to as being "net" amounts of materials and services since they account for any natural uranium diluent that would be purchased in the commercial market to support the down blending of HEU.

This analysis assumes quantities of 2,055 MTU per year for the EM barters and 650 MTU per year for the NNSA barters as the limiting case. Note that the NNSA barters are in the form of LEU while the EM barters are in the form of natural UF_6, which has no enrichment services component.

The combined EM and NNSA barters are steady at 2,705 MTU as UF_6 per year through 2018, but then decline in 2019 as inventories of natural UF_6 are exhausted. The NNSA HEU currently identified for down blending is exhausted by the end of 2022. The corresponding quantity of U_3O_8 is 7.1 million pounds per year through 2018 before the decline starts in 2019. Only the NNSA barters contain an enrichment component, which is level at 0.6 million SWU per year through 2021and then declines to zero by 2023. Total EM and NNSA barters from 2014 through 2022 are 16,417 MTU as UF_6 equivalent, containing 43 million pounds of U_3O_8, and 5.1 million SWU.

3.3 Proposed DOE Inventory Transfers Currently Under Negotiation

Additional high-assay[19] DUF_6, which is considered to be economically viable by the purchaser for the purpose of enrichment to NU-equivalent or to LEU, is the only significant remaining excess inventory with potential market value that DOE can introduce into the commercial markets. DOE released a RFO for its remaining inventories of high-assay DUF_6, as well as for small quantities of off-spec LEU, in July 2013.[20] The RFO specified that natural uranium created from the DUF_6 could not enter the market before 2019 and would be limited to 2,000 MTU per year. At the end of November 2013, DOE announced it would open negotiations with GLE for the sale of high-assay DUF_6. GLE proposed to license, construct and operate a new laser enrichment facility at Paducah for the processing of the tails material. The proposed Paducah Laser Enrichment Facility would re-enrich the DUF_6 to 0.711 w/o, creating natural uranium in the form of UF_6 that would then be sold into the uranium market.

In addition to the potential transfer of high-assay DUF_6, the unallocated DOE excess inventories include a small quantity of off-spec non-UF_6 that could enter the commercial market between 2019 and 2023. As a result of the July 2013 RFO, in November 2013 DOE announced that it had entered into negotiations with AREVA for the sale of this material. In 2009, the Portsmouth DOE contractor issued an RFP to sell certain Off-Spec Non-UF_6 material. No decision has yet been made as to whether any material will be sold under that RFP.

[19] DOE considers DUF_6 with an assay of 0.34 w/o U^{235} or higher to be economically viable for the purpose of enrichment to NU-equivalent or LEU. DOE's inventory of such high-assay DUF_6 is 114,000 MTU as DUF_6.

[20] U. S. DOE, Portsmouth/Paducah Project Office, Request for Offers for the Sale of Depleted and Off-Specification Uranium Hexafluoride Inventories, Request for Offers Number: DE-SOL-0005845, July 3, 2013.

Laser Enrichment of DUF_6 to Natural Uranium

A construction schedule has not been set, but commercial negotiations between DOE and GLE were expected to be completed in early 2014, and are ongoing as of April 1, 2014. Following the successful completion of negotiations, GLE will need to apply for a license to construct and operate a laser enrichment facility at the Portsmouth site from the U.S. NRC. GLE notified the NRC that it intends to submit an application in September 2014. While GLE requested an expedited 25-month review with license approval by November 2016, the NRC indicated such licensing actions generally take at least 30 months. While a timeline for the construction of the proposed laser enrichment facility has not been made public, ERI does not believe operations could begin until the year 2020 at the earliest. An enrichment plant of 1.6 million SWU could produce 2,000 MTU of natural uranium equivalent per year from the DOE DUF_6 if an operating tails assay of 0.15 w/o is assumed. It would take 20 years to process the high-assay DUF_6 inventory at this rate. The claimed high selectivity of the proposed Silex technology implies an even lower operating tails assay, but the inherent operating tails assay of the Silex technology remains protected information. If the facility were to operate at 0.20 w/o, then a 1.1 million SWU plant could produce 2,000 MTU of natural uranium per year and the high-assay DUF_6 inventory could be processed over a 17 year period. GLE does not currently plan to enrich the DUF_6 beyond 0.711 w/o enrichment level, citing additional restrictions with the NRC and DOE. If the proposed GLE facility is successful, then additional quantities of DUF_6 with assays lower than 0.34 w/o might be re-enriched economically in the future, but no such plans exist at present.

Off-Specification Material

In addition to the DUF_6, the unallocated DOE excess inventories include a small quantity (221 MTU) of off-spec non-UF_6, with product assays ranging between 0.711 w/o and 4.9 w/o and 167 MTU of off-spec LEU with an average assay of 1.6 w/o. In 2009, the Portsmouth DOE contractor issued an RFP to sell certain Off-Spec Non-UF_6 material. No decision has yet been made as to whether any material will be sold under that RFP.. In November 2013 DOE also announced that it had entered into negotiations with AREVA for the commercialization of the off-spec LEU material. DOE expects that a small amount of the off-spec non- UF_6 will enter the commercial markets in 2015 and 2016 followed by the off-spec LEU between 2019 and 2023. The remaining off-spec non-UF_6 is not viewed as commercially viable at this time. The natural uranium equivalent quantity of the off-spec non-UF_6 entering the market in 2015 and 2016 totals 30 MTU as UF_6 while the off-spec LEU entering the market in 2019 to 2023 totals 480 MTU as natural uranium equivalent. The material transfers that would result from the negotiations associated with DOE inventory RFOs are summarized in Table 3.3. The off-spec material has a small enrichment equivalent, estimated by ERI to be about 0.2 million SWU in total.

Year	Natural Uranium Equivalent, MTU				Equivalent Million Pounds of U_3O_8 (a)			
	DUF_6	Off-Spec LEU	Off-Spec non-UF_6	Total	DUF_6	Off-Spec LEU	Off-Spec non-UF_6	Total
2012								
2013								
2014								
2015			15	15			0.0	0.0
2016			15	15			0.0	0.0
2017								
2018								
2019		96		96		0.3		0.3
2020	2,000	96		2,096	5.2	0.3		5.5
2021	2,000	96		2,096	5.2	0.3		5.5
2022	2,000	96		2,096	5.2	0.3		5.5
2023	2,000	96		2,096	5.2	0.3		5.5
2024	2,000			2,000	5.2			5.2
2025	2,000			2,000	5.2			5.2
2026	2,000			2,000	5.2			5.2
2027	2,000			2,000	5.2			5.2
2028	2,000			2,000	5.2			5.2
2029	2,000			2,000	5.2			5.2
2030	2,000			2,000	5.2			5.2
2031	2,000			2,000	5.2			5.2
2032	2,000			2,000	5.2			5.2
2033	2,000			2,000	5.2			5.2
Total 2014-33	28,000	480	30	28,510	73.2	1.3	0.1	74.5

(a) Calculated by multiplying the MTU as UF6 value by a conversion factor of 0.00261285.

(b) The Off-Spec LEU averages 1.6 w/o with an estimated enrichment equivalent of approximately 0.2 million SWU total. The total enrichment content of the Off-Spec Non-UF6 is estimated as less than 0.03 Million SWU.

Table 3.3 Proposed DOE Inventory Transfers Currently Under Negotiation

3.4 Summary of All DOE Material Entering the Commercial Markets

As described in the previous sections, there are three broad categories of material for which DOE inventory is expected to be introduced into the commercial markets. They include (i) historical DOE transfers still displacing commercial supply in the markets, as presented in Table 3.1; (ii) ongoing inventory transfers in exchange for services (barters), as presented in Table 3.2; and (iii) proposed transfers of additional DUF_6, off-spec LEU, and off-spec non-UF_6 that are currently under negotiation with selected companies, as a result of earlier DOE RFOs as presented in Table 3.3.

The entry of natural uranium equivalent into the commercial uranium and conversion markets is shown in Figure 3.1, with the EM and NNSA barters shown individually. The NNSA barters are expected to increase, but the EM barters will decrease correspondingly. The barters are the primary source of DOE inventory entering the market over the next five

years (through 2018). The proposed transfers of DOE inventory, which are currently under negotiation with selected companies as a result of earlier DOE RFOs, are the primary source of DOE inventory entering the market in the longer term (2020 and beyond). They are shown with a dashed outline in Figure 3.1 as they are only proposed at present and include proposed transfers of DUF_6, off-spec LEU, and a limited amount of off-spec non-UF_6.

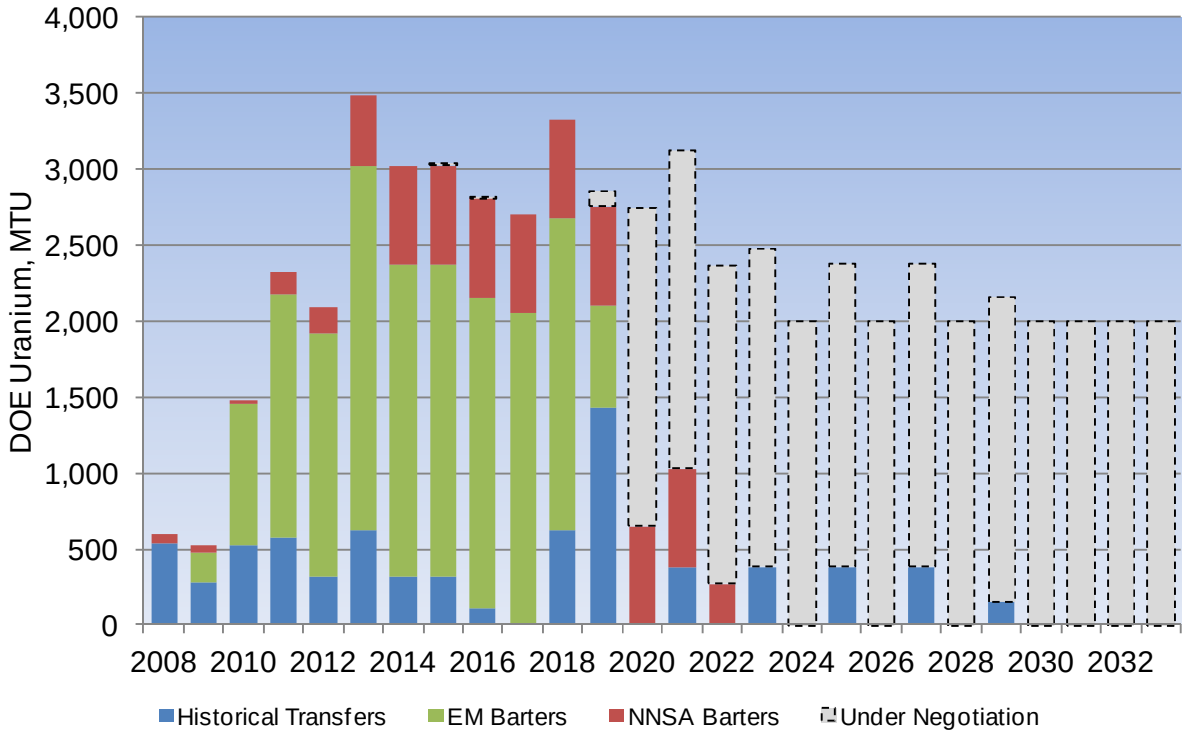


Figure 3.1 DOE Inventory Entering the Commercial Uranium Market

Table 3.4 shows the annual and total equivalent net natural UF_6, equivalent uranium concentrates, and enrichment services, respectively, based on when the material supplies the commercial market. During the period 2014 to 2033, the total DOE inventory entering the market equals about 49,000 MTU as UF_6, which is equivalent to 129 million pounds of U_3O_8. A total of 9.7 million SWU will enter the market during the period 2014 to 2023. No additional equivalent SWU are identified to enter the market after 2023.

Year	MTU as UF_6	Equiv. U_3O_8 (Million lbs)	Equiv. SWU (Millions)
2012	2,095	5.5	1.0
2013	3,486	9.1	0.8
2014	3,023	7.9	1.3
2015	3,038	7.9	1.4
2016	2,823	7.4	0.9
2017	2,705	7.1	0.8
2018	3,329	8.7	0.8
2019	2,851	7.4	1.4
2020	2,746	7.2	0.8
2021	3,127	8.2	1.4
2022	2,367	6.2	0.7
2023	2,477	6.5	0.4
2024	2,000	5.2	
2025	2,381	6.2	
2026	2,000	5.2	
2027	2,381	6.2	
2028	2,000	5.2	
2029	2,158	5.6	
2030	2,000	5.2	
2031	2,000	5.2	
2032	2,000	5.2	
2033	2,000	5.2	
Totals:			
2014-23	28,486	74.4	9.7
2024-33	20,920	54.7	
2014-33	49,406	129.1	9.7

(a) Calculated by multiplying the MTU as UF6 value by a conversion factor of 0.00261285.

(b) Totals may not add due to rounding.

(c) Quantities based on time of market entry.

Table 3.4 Total Equivalent Net MTU as UF_6, Million Pounds of U_3O_8 and Million SWU Entering the Market

As previously stated, 50% of the natural uranium that DOE transfers to the contractor(s) via EM barters is introduced through spot market contracts and 50% through term market contracts. It is assumed that 100% of the natural uranium content of the NNSA barters is introduced into the spot market. The historical transfer of high assay DUF_6 to ENW and off-spec HEU to TVA is still displacing commercial supply, as the LEU created by ENW and TVA from the transferred materials continues to be delivered under long-term arrangements. Anticipated transfers of DOE inventory, which are currently under negotiation as a result of earlier DOE RFOs (primarily additional high assay $DUF_{6)}$, are

assumed to be introduced on a 50% spot and 50% term basis. This is considered a conservative assumption, as the uranium created from DUF_6 in the future may well enter the market on a term basis only, as was the case with the first DUF_6 transfer. The total amount of DOE inventory entering the commercial spot markets is shown in Table 3.5. A comparison of Tables 3.4 and 3.5 indicates that 53% of the natural uranium equivalent component of the DOE inventories delivered into the commercial markets over the next ten years is expected to take place under spot market contracts, with the remaining 47% delivered under term market arrangements. The spot market share declines slightly, to 48%, for the following ten years (2024-2033).

Year	MTU as UF_6	Equiv. U_3O_8 (Million lbs)	Equiv. SWU (Millions)
2012	977	2.6	0.3
2013	1,659	4.3	0.5
2014	1,678	4.4	0.6
2015	1,693	4.4	0.6
2016	1,692	4.4	0.6
2017	1,678	4.4	0.6
2018	1,678	4.4	0.6
2019	1,035	2.7	0.6
2020	1,698	4.4	0.6
2021	1,698	4.4	0.6
2022	1,319	3.4	0.3
2023	1,048	2.7	0.0
2024	1,000	2.6	
2025	1,000	2.6	
2026	1,000	2.6	
2027	1,000	2.6	
2028	1,000	2.6	
2029	1,000	2.6	
2030	1,000	2.6	
2031	1,000	2.6	
2032	1,000	2.6	
2033	1,000	2.6	
Totals:			
2014-23	15,214	39.8	5.2
2024-33	10,000	26.1	
2014-33	25,214	65.9	5.2

(a) Calculated by multiplying the MTU as UF6 value by a conversion factor of 0.00261285.

(b) Totals may not add due to rounding.

(c) Quantities based on time of market entry.

Table 3.5 Total DOE Inventory Entering the Spot Market

The commercial supply displaced by DOE inventory transfers is expected to average nearly 2,850 MTU as UF_6, equivalent to 7.4 million pounds U_3O_8 per year over the next ten years (2014 through 2023). This is equivalent to approximately 15% of annual U.S. uranium requirements and 15% of U.S. conversion requirements. During the subsequent ten years (2024-2033) the DOE inventory entering the commercial uranium market declines to an average of 5.5 million pounds per year, or nearly 12% of U.S. uranium requirements.

The equivalent enrichment services contained in DOE inventory entering the market over the next ten years averages 0.97 million SWU per year. This is equivalent to 6% of U.S. requirements. No additional enrichment services from DOE inventory is expected to enter the commercial enrichment market in the subsequent ten years.

The enrichment transfers are potentially subject to some offsets when evaluating the impact on industry. The LEU created from DUF_6 transferred to ENW contains 3.2 million SWU, but was offset by the purchase of a combined 4.4 million SWU in 2012 and 2013 from USEC. In order to be conservative, this analysis treats the enrichment content of the ENW LEU created from DUF_6 as a potential market impact. The processing of additional DUF_6 by GLE, which is currently under negotiation between GLE and DOE as a result of DOE's 2013 RFO, effectively creates a new demand on U.S. industry for an estimated 1.6 million SWU per year (starting in 2020). Again, to be conservative, this analysis does not treat the new GLE enrichment demand as an offset to the enrichment content of other DOE inventory entering the commercial enrichment market.

4. Quantification of the Impact of DOE Material Entering the Commercial Markets

4.1 Potential Effect of DOE Inventory on Market Prices

ERI continues to believe that the change in market price due to DOE inventory entering the market provides an important measure of the DOE material's impact on the domestic industry. However, there is no absolute measure of the isolated effect any one particular market factor or event, such as the DOE inventory material, has on market prices. There are many market factors which combine to determine the relationship between supply and demand, and ultimately market prices as found in published price indicators. DOE inventory entering the commercial markets is certainly one of the market factors, but the DOE inventory must be judged in the context of its relative importance when compared to other market factors. A reasonable judgment on the specific contribution of DOE inventories to observed market price changes can then be made.

By applying the results of ERI's economic market clearing price analysis, which is summarized in Sections 4.1.1 below, regarding the potential impact of an incremental addition of supply on the market clearing price of uranium concentrates, conversion services and enrichment services, respectively, to the equivalent nuclear fuel materials and services contained in DOE's inventory transfers, the effect on market price may be estimated as presented below.

4.1.1 Potential Impact of DOE Inventory on Market Prices Based on Market Clearing Price Analysis

A market clearing price approach has been employed to determine the effect of changes in individual components of supply on market prices. ERI chose the market clearing approach because it assumes an efficient allocation of resources in a competitive market and is consistent with the view that long term prices are determined by production costs and future supply-demand forecasts. Using this approach also allows the price impact of any single supply component, such as DOE inventory, to be estimated. This market clearing approach requires the creation of an annual supply curve, which in the case of uranium concentrates is constructed by stacking individual increments of supply (e.g., individual mines) in ascending order from low to high based on each increment’s cost of production. The market clearing price is the total cost of production for the last increment of supply that is required to meet demand during that year. The supply curve created by ERI for the year 2013 is shown in Figure 4.1. Note that the supply curve assumes secondary supply is always utilized first, followed by primary production. In over supplied markets such as the current uranium market, the amount of mine production required to meet requirements, including normal strategic inventory building, is well below actual production.

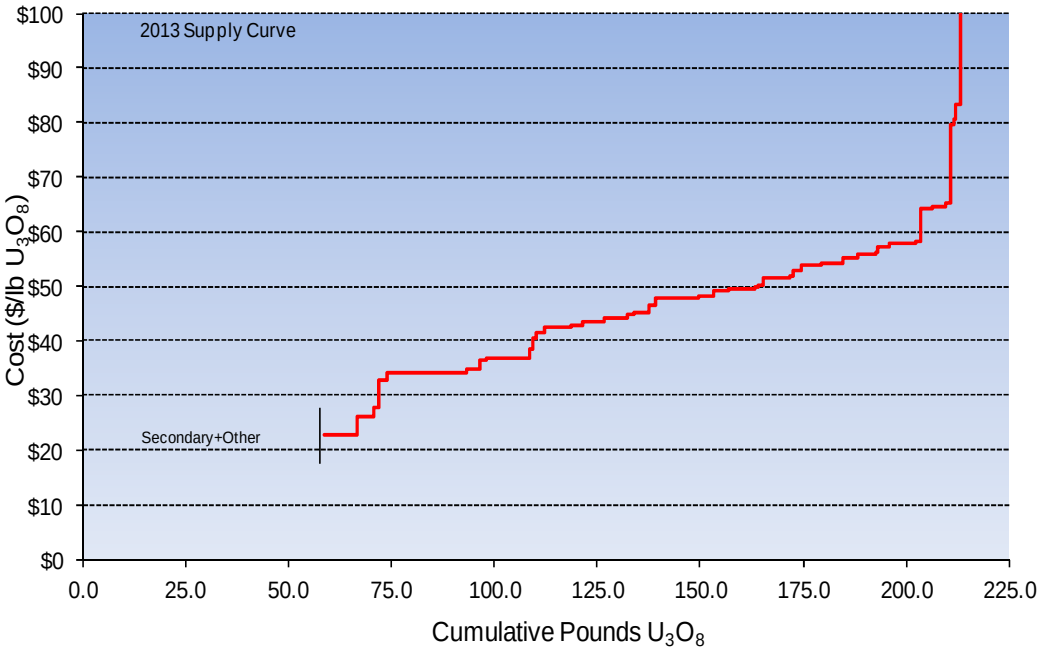


Figure 4.1 ERI Supply Curve for 2013

The change in market clearing price attributed to a particular component of secondary supply, such as the DOE inventory, is found by removing the market component in question from secondary supply. This has the effect of moving the supply curve to the left, resulting in a higher market clearing price for the same requirements, as demonstrated in Figure 4.2. In a market with considerable oversupply such as today's market, the removal of a particular component of secondary supply would likely not result in a corresponding amount of new primary supply entering the market in its place since there is already more production than needed to cover requirements available in the market.

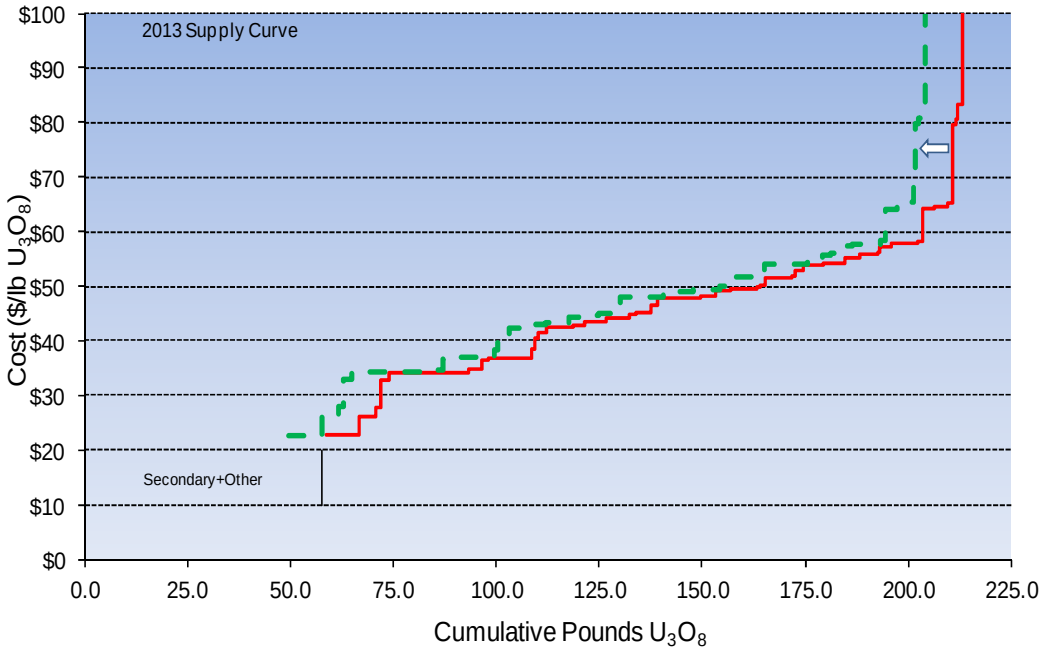


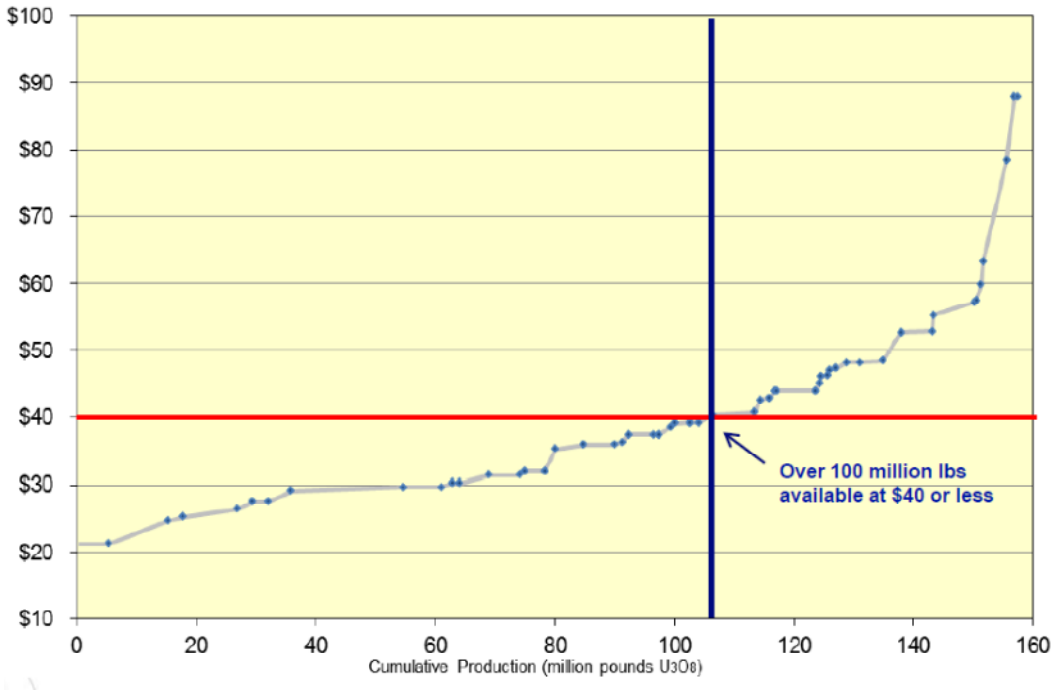
Figure 4.2 ERI Supply Curve if DOE Inventory is Removed

The relevant slope of the supply curve (i.e., Δ$ per pound / Δ million pounds) can be determined from the difference of the two clearing prices (e.g. without and with DOE inventory) divided by the quantity removed (e.g. the DOE inventory entering the market). During the next ten years, the relevant slope of the supply curve is found to average $0.375 per pound U_3O_8 for each one million pound change in supply.

The supply curve developed by ERI appears to be consistent with the work of other market analysts[21,22], as shown in Figures 4.3 and 4.4. These supply curves examine total production cost and production cash cost, respectively. Each is consistent with a slope of $0.40 per pound U_3O_8 for each one million pound change in supply in the relevant portion of the supply curve.

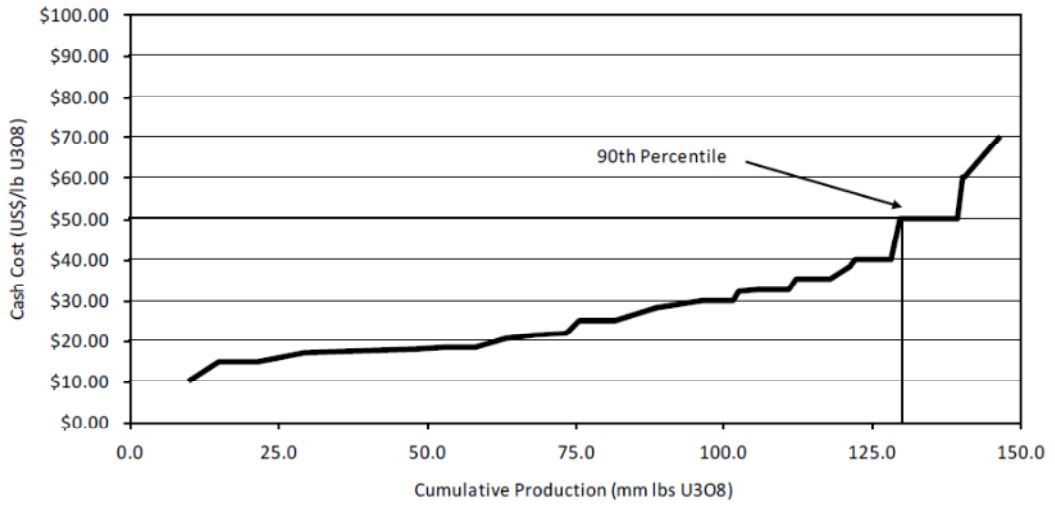
[21] Ux Consulting Company, "Is $35 the New $10: A Case for Production Delays and Cutbacks", NEI International Uranium Fuel Seminar 2013, October 7, 2013

[22] RBC Capital Markets, Metal Prospects, "Uranium Metal Prospects: Uranium Market Outlook – Third Quarter 2013", June 18, 2013



Source: UxC

Figure 4.3 UxC Production Cost Curve for 2013



Source: RBC

Figure 4.4 RBC Production Cash Cost Curve for 2013

Similar production cost analysis coupled with economic market clearing price analysis has been conducted for conversion and enrichment facilities. The resulting supply curve slopes are found to average $0.31 per kgU as UF_6 for each one million kgU change in conversion supply and $4.1 per SWU for each one million SWU change in enrichment supply during the next ten years The supply curve slopes for the uranium concentrates, conversion services, and enrichment services markets have been applied to the DOE inventory material entering the commercial

markets, which were summarized in Table 3.4 in Section 3. The resulting year-by-year changes in clearing price attributed to the DOE material are presented in Table 4.1. During the next ten years (2014-2023), the change in clearing price attributed to the DOE inventories averages approximately $3/lb for the uranium market, $1/kgU for the conversion market and $4/SWU for the enrichment market.

Year	Conversion ($/kgU)	Uranium ($/lb U_3O_8)	Enrichment ($/SWU)
2012	$0.6	$2.1	$3.9
2013	$1.1	$3.4	$3.4
2014	$0.9	$3.0	$5.2
2015	$0.9	$3.0	$5.7
2016	$0.9	$2.8	$3.6
2017	$0.8	$2.7	$3.1
2018	$1.0	$3.3	$3.1
2019	$0.9	$2.8	$5.9
2020	$0.9	$2.7	$3.3
2021	$1.0	$3.1	$5.6
2022	$0.7	$2.3	$2.7
2023	$0.8	$2.4	$1.4
2024	$0.6	$2.0	
2025	$0.7	$2.3	
2026	$0.6	$2.0	
2027	$0.7	$2.3	
2028	$0.6	$2.0	
2029	$0.7	$2.1	
2030	$0.6	$2.0	
2031	$0.6	$2.0	
2032	$0.6	$2.0	
2033	$0.6	$2.0	
Totals:			
2014-23	$0.9	$2.8	$4.0
2024-33	$0.6	$2.0	
2014-33	$0.8	$2.4	

Table 4.1 Changes in Clearing Price Due to DOE Inventory

Tables 4.2 and 4.3 restate the changes in clearing price relative to current term and spot market prices[23] in order to provide some additional perspective. During the next ten years (2014-2023), the change in clearing price attributed to the DOE inventories averages approximately 6% for the uranium market, 6% for the conversion market and 4% for the enrichment market relative to current term prices. There is a larger effect for the spot

[23] TradeTech price indicators as of March 31, 2014.

conversion and uranium markets, where the change in clearing price attributed to the DOE inventories averages approximately 12% for the conversion market and 8% for the uranium market. The relative change remains at 4% for the enrichment spot market. These relative changes are higher than was calculated two years ago[24], primarily due to the decline in the market price indicators.

Year	Conversion Services	Natural Uranium	Enrichment Services
2012	4.1%	4.6%	4.0%
2013	6.8%	7.6%	3.4%
2014	5.9%	6.6%	5.2%
2015	5.9%	6.6%	5.7%
2016	5.5%	6.1%	3.6%
2017	5.2%	5.9%	3.2%
2018	6.4%	7.2%	3.2%
2019	5.5%	6.2%	5.9%
2020	5.3%	6.0%	3.3%
2021	6.1%	6.8%	5.7%
2022	4.6%	5.2%	2.7%
2023	4.8%	5.4%	1.5%
2024	3.9%	4.4%	
2025	4.6%	5.2%	
2026	3.9%	4.4%	
2027	4.6%	5.2%	
2028	3.9%	4.4%	
2029	4.2%	4.7%	
2030	3.9%	4.4%	
2031	3.9%	4.4%	
2032	3.9%	4.4%	
2033	3.9%	4.4%	
Totals:			
2014-23	5.5%	6.2%	4.0%
2024-33	4.1%	4.6%	
2014-33	4.8%	5.4%	

Table 4.2 Changes in Clearing Price Relative to Current Term Market Price

[24] Energy Resources International, " 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", ERI-2142.12-1201, April 23, 2012.

Year	Conversion Services	Natural Uranium	Enrichment Services
2012	8.7%	6.0%	4.1%
2013	14.4%	10.0%	3.5%
2014	12.5%	8.7%	5.4%
2015	12.6%	8.8%	5.9%
2016	11.7%	8.1%	3.7%
2017	11.2%	7.8%	3.3%
2018	13.8%	9.6%	3.3%
2019	11.8%	8.2%	6.1%
2020	11.4%	7.9%	3.4%
2021	12.9%	9.0%	5.9%
2022	9.8%	6.8%	2.8%
2023	10.2%	7.1%	1.5%
2024	8.3%	5.8%	
2025	9.8%	6.9%	
2026	8.3%	5.8%	
2027	9.8%	6.9%	
2028	8.3%	5.8%	
2029	8.9%	6.2%	
2030	8.3%	5.8%	
2031	8.3%	5.8%	
2032	8.3%	5.8%	
2033	8.3%	5.8%	
Totals:			
2014-23	11.8%	8.2%	4.1%
2024-33	8.6%	6.0%	
2014-33	10.2%	7.1%	

Table 4.3 Changes in Clearing Price Relative to Current Spot Market Price

4.1.2 Potential Impact of DOE Inventory on Uranium Spot Market Price

ERI has developed a multivariable correlation between the monthly spot market prices for uranium concentrates published by TradeTech and the monthly spot market values of supply and demand, which are also published by TradeTech. This correlation covers the period from July 2004 through March 31, 2014 and has an R^2 = 90%, which indicates a reasonable correlation, particularly given the extreme volatility experienced in the spot market price during this period. A comparison of the actual spot market prices with the correlation is provided in Figure 4.5

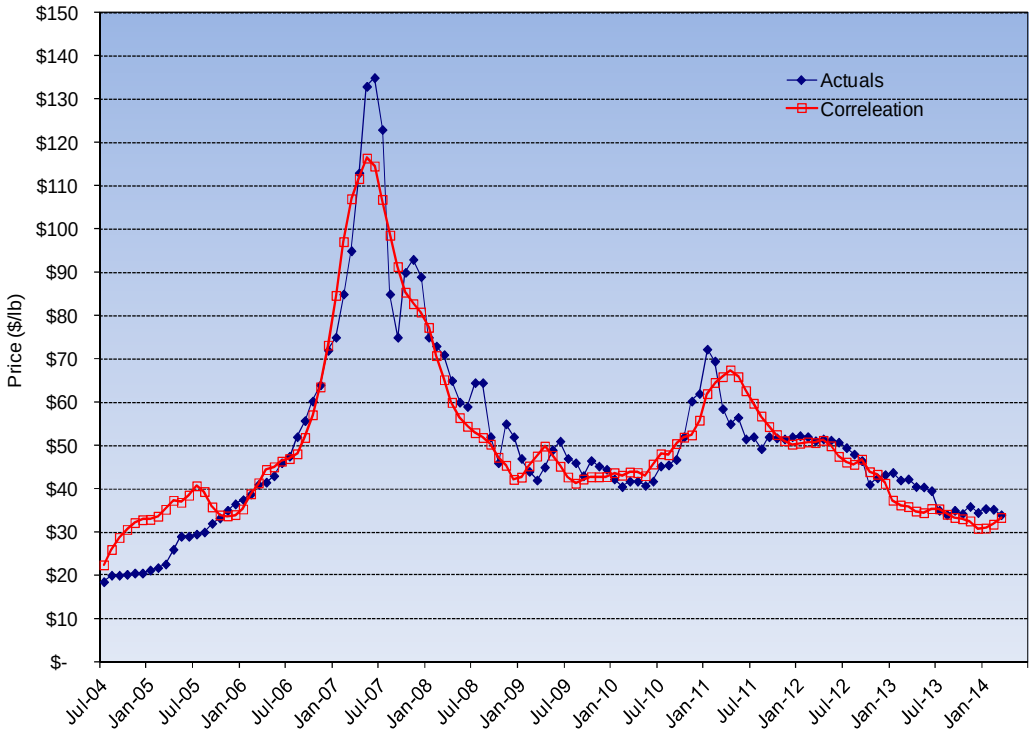


Figure 4.5 Spot Market Prices for Uranium – Actual versus Correlation

This correlation was then used to simulate the 2009 through 2021 spot market price for uranium concentrates with and without the DOE inventory entering the spot market, as shown in Figure 4.6.

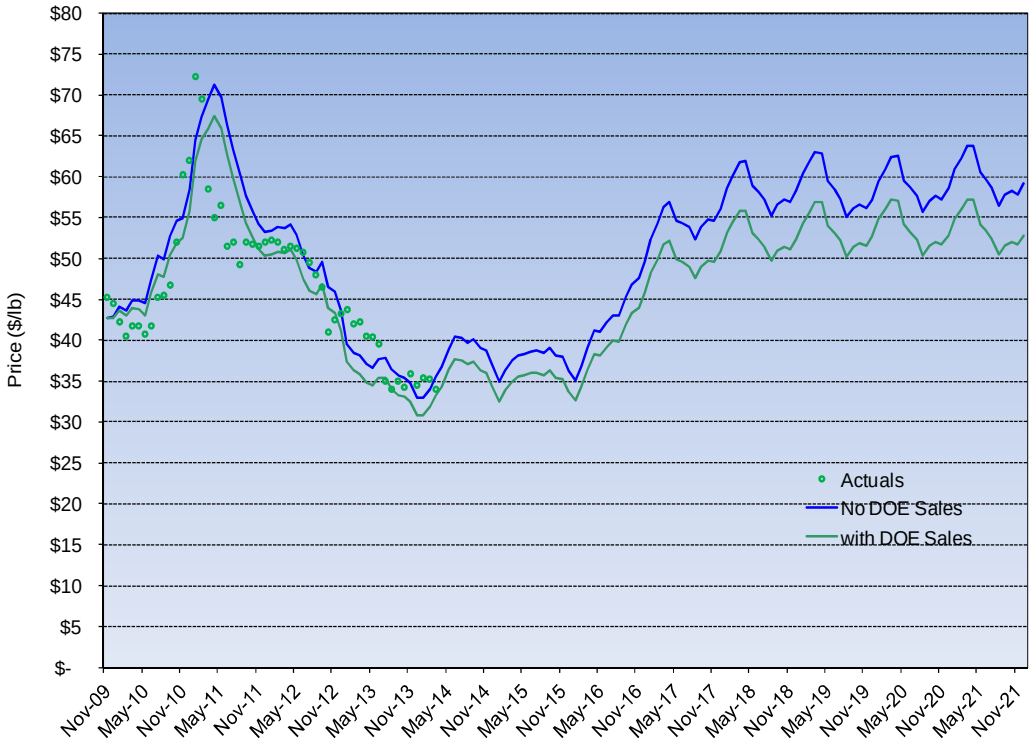


Figure 4.6 Estimate of Uranium Spot Market Price Change Due to DOE Inventory Using Correlation

Historical auctions of DOE material were modeled as they took place. Since Traxys took over the commercialization of EM transfers, it is no longer possible to explicitly identify when and how much of this DOE origin material is introduced into the commercial markets by Traxys at any point in time, even though Traxys receives the material on a quarterly basis. This is due to the fact that at least 50% of sales of DOE material by Traxys take place under mid- and long-term contacts.[25] For use in the correlation, the DOE inventory entering the spot market is assumed to take place evenly through the year, i.e. one-twelfth of the annual amount each month.

The results of applying this correlation are projections of a potential spot market price decrease of $2.8 per pound U_3O_8 over the next three years (2014-2016) but then rises to an average decrease of $5.5 between 2017 and 2021 as spot market prices recover. This represents an estimated impact on spot market price of 7% to 9% from DOE inventory entering the uranium market.

In a paper[26] presented at the June 2013 World Nuclear Fuel Market meeting, industry consultant TradeTech estimated the impact on spot prices of DOE inventory releases to be

[25] Smith, Kevin, Director Uranium Trading and Marketing, Traxys, Commercial View of DOE's 2013 Plan for Natural Uranium Barter Sales, Nuclear Energy Institute, International Uranium Fuel Seminar, October 6-9, 2013, San Antonio, Texas.

[26] TradeTech LLC, DOE Inventory: Impact & Consensus, World Nuclear Fuel Market, Istanbul, Turkey,

$2/lb between mid-2012 and mid-2013.[27] TradeTech made use of its econometric model which relates active supply to active demand on the spot market to estimate the price impact of the DOE inventory releases. The analysis used in the presentation is not based on clearing price methodology, but does result in an estimation of price impact which is similar to the impact estimated by ERI using both the clearing price methodology and the econometric model. The presentation concluded that "To evaluate a true material impact we need to assess the influence on company profits" and found that "This indicates significant potential impact ranging from 5%-32%" of profits based on applying the $2/lb price impact to three different producer profile examples. The presentation also stated TradeTech's belief that the consensus view remains the need for predictability and price sensitivity.

4.2 Potential Impact on Domestic Industries

The potential effect of the entry of DOE materials and services into the commercial markets discussed above on each of these domestic industries is discussed further in the following sections.

4.2.1 Potential Impact on the Domestic Uranium Concentrates Industry

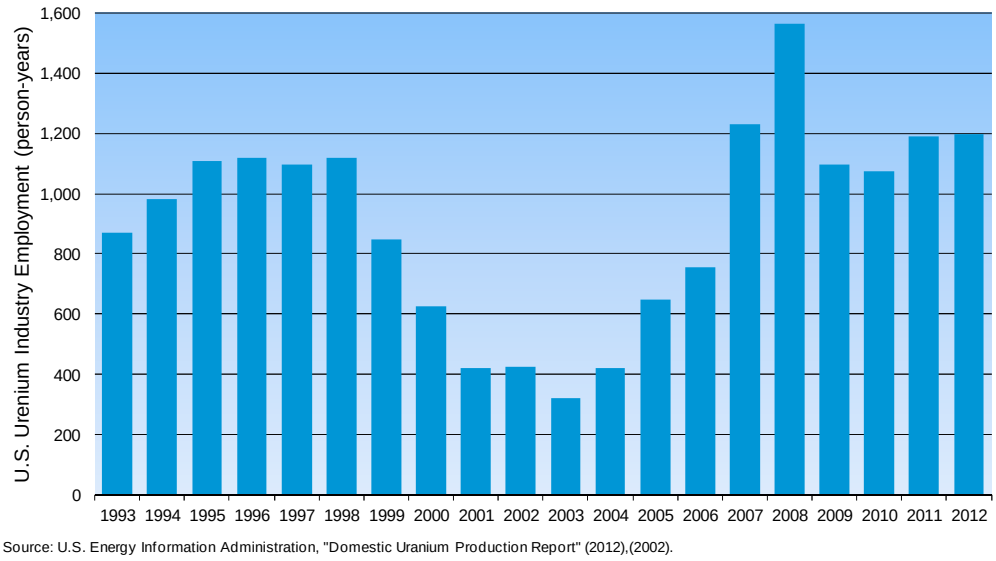
ERI continues to believe that the change in market price provides the best measure of, and is the best singly proxy for, market impact. The analysis has been expanded to relate how a change in market price impacts key metrics of the domestic uranium industry, in particular, employment and production.

U.S. Uranium Industry Employment

Total U.S. uranium industry employment, as measured by responses to U.S. Energy Information Administration Form EIA-858, has ranged between 321 and 1,563 person-years over the past 20 years. As shown in Figure 4.7, employment reached its low point in 2003, but then steadily increased over the following five years, peaking in 2008. The large employment gains in 2007 and 2008 were driven by the rapid run up in uranium prices, which resulted in increased employment at uranium production centers as well as increased exploration employment. Figure 4.7 demonstrates that the employment increase lagged the price increases by about one year.

June 2013.

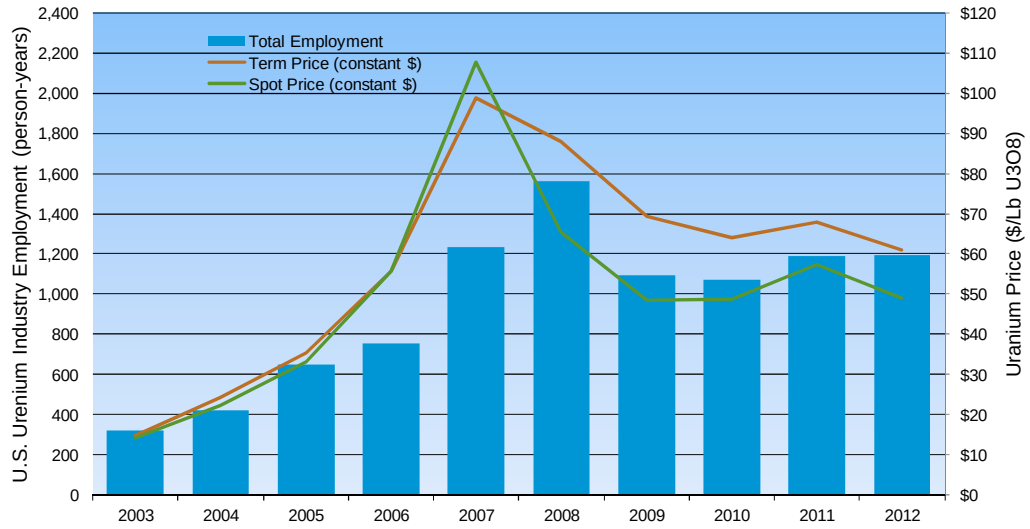
[27] This $2/lb impact between mid-2012 and mid-2013 is similar to the average market impact of $1.78 to $1.86/lb U_3O_8 for the period 2012 to 2020 calculated by ERI in its 2012 market impact study.



Source: U.S. Energy Information Administration, "Domestic Uranium Production Report" (2012),(2002).

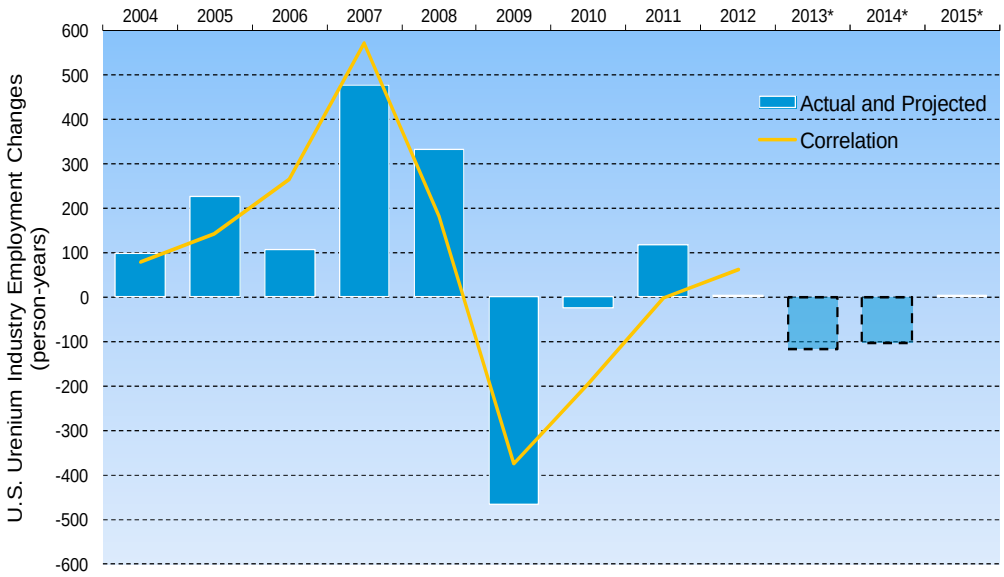
Figure 4.7 U.S. Uranium Industry Employment History

U.S. uranium industry employment over the past ten years appears to respond to changes in uranium price, as shown in Figure 4.8. In particular, it was found that changes in industry employment from year-to-year are well correlated to the two-year average prices (current and preceding year) in constant dollars, as shown in Figure 4.9. The R^2 for the correlation is 0.80, indicating that 80% of the observed changes in employment are consistent with the observed changes in market price. The correlation indicates that industry employment in 2013 is expected to decline by approximately 120 person-years from the 2012 value, or about 10% as shown in Figure 4.9. This estimation is consistent with announcements that have been made by domestic industry participants. As was noted previously, changes in industry employment tend to lag or trail price changes, so an additional decline of approximately 90 is estimated for 2014, again consistent with some announcements that have already been made.



Source: U.S. Energy Information Administration, "Domestic Uranium Production Report" (2012),(2002).

Figure 4.8 U.S. Uranium Industry Employment Relation to Market Prices



Source: U.S. Energy Information Administration, "Domestic Uranium Production Report" (2012),(2002).
* 2013-2015 values estimated by Energy Resources International, Inc.

Figure 4.9 Change in U.S. Uranium Industry Employment - Actual and Projected

The price-employment correlation has been used to estimate the impact of the DOE inventory releases on U.S. uranium industry employment. The total price impact of DOE inventory releases in 2012 is estimated to be about $2/lb (see Table 4.1). The correlation indicates this price change lowered employment by 31 person-years in 2012. In other

words, employment was reduced by 2.5%[28] in 2012 as a result of the DOE inventory releases. As noted above, due to the decrease in the price for uranium concentrates, an employment loss of 120 person-years is projected for 2013. The estimate of the impact of DOE material on market price in 2013 is a price impact of $3.4/lb (see Table 4.1), resulting in an estimated employment loss of 50 person-years as a result of the DOE inventory entering the market. This corresponds to a reduction in uranium industry employment of 4.4% in 2013. The price impact of the 2.1 million pound increase in EM barters for 2013 is estimated to be $0.8/lb[29], which is responsible for 11 of the estimated total 50 person-year employment loss attributed to all DOE inventory releases based on the price-to-employment correlation.

Looking forward, the impact of DOE uranium inventory entering the commercial market is expected to average nearly $3/lb over the next ten years (2014-2023), as was discussed in Section 4.1. This results in an estimated long-term employment loss of 44 person years, meaning that future employment is reduced by approximately 4%[30] on average as a result of the DOE inventory releases.

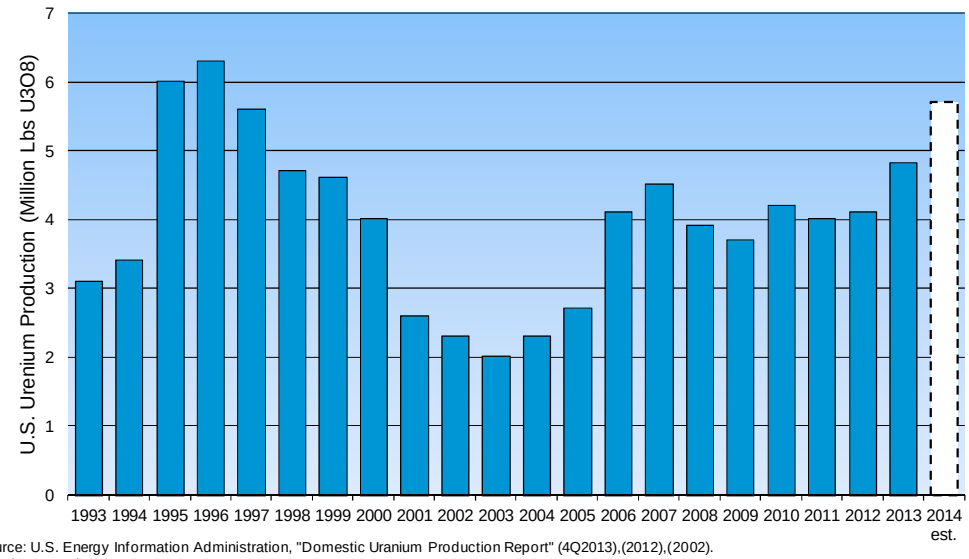
U.S. Uranium Production

A history of U.S. uranium industry production is provided in Figure 4.10. Production has generally risen since the low of 2 million pounds in 2003. U.S. production has also risen since the start of the DOE uranium inventory barters in December 2009, with a noticeable increase taking place in 2013. Four new operations have started production since 2009 - Uranium One's Willow Creek in 2010, UEC's Hobson/Palangana in late 2010/early 2011, Ur-Energy's Lost Creek in 2013, and Uranerz's Nichols Ranch in 2014. One additional production center is expected to start operations in 2014 - Peninsula's Lance.

[28] Percentage calculated by comparing loss due to DOE (31) with 2012 actual employment (1196) plus DOE loss, or 31 / (1196+31) = .025 or 2.5%.

[29] Increase of 2.1 million pounds multiplied by supply slope of $0.375 equals $0.8 per pound.

[30] Percentage calculated by comparing estimated loss due to DOE (44) with estimated 2014-2023 average employment before DOE loss (1,115), or 44 / (1159) = .038 or 4%



Source: U.S. Energy Information Administration, "Domestic Uranium Production Report" (4Q2013),(2012),(2002).
2014 is ERI estimate.

Figure 4.10 U.S. Uranium Industry Production, 1993 - 2013

Despite the overall increase in U.S. uranium production over the past five years, the decline in prices has impacted the actual and planned production of some U.S. operations. Announced cut backs at existing operations include the following:

- 4Q/2012 Energy Fuels placed its Daneros, Beaver and Pandora mines on standby.
- 2Q/2013 Uranium One announced that it will not develop new well fields at Willow Creek.
- 09/2013 UEC defers further capital expenditures for Palangana production wellfields and reduces operations.
- 11/2013 Energy Fuels - Arizona 1 mine is expected to cease in early FY-2014 due to the depletion of its known resources. Mining at the Pinenut mine will be put on standby in mid 2014.

The combined reduction in production from these cutbacks was limited in 2013 but is expected to be about 1.0 million pounds in 2014. As already noted, total U.S. production is expected to increase in 2014 as new production more than offsets the cutbacks.

DOE Inventory Relative to Total Market Supply

To better judge the DOE inventories role in the uranium market, Figure 4.11 compares the DOE quantities that have or are expected to enter the uranium market to total uranium market supply, where the supply is broken down between primary production and secondary supply. The DOE inventory's share of total uranium market supply has grown from about 1% in 2008 to 4% currently. For the longer term, as requirements exceed 200 million pounds and total supply then starts to increase, the DOE share will start to decline.

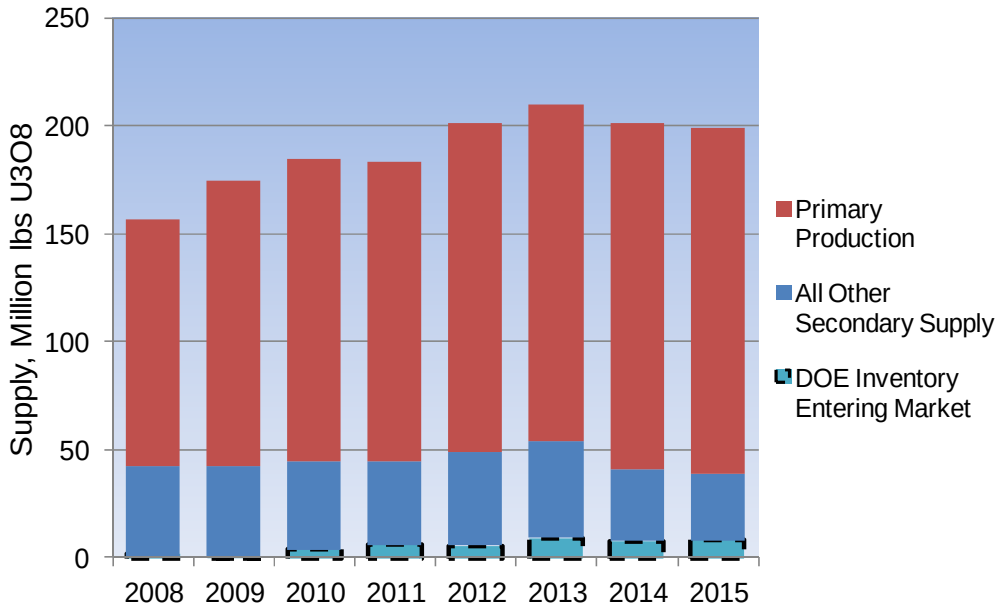


Figure 4.11 DOE Inventory Relative to Total Uranium Market Supply

Figure 4.12 compares the DOE inventory relative to total secondary supply for selected years. The DOE inventory has grown from 4% of secondary supply in 2008 to 17% in 2013. The DOE inventory has been responsible for about two-thirds of the net increase in secondary supply during this period. Secondary supply declines in 2014 with the end of the HEU Agreement, resulting in an increase in the DOE inventory's share of total secondary supply to approximately 19%.

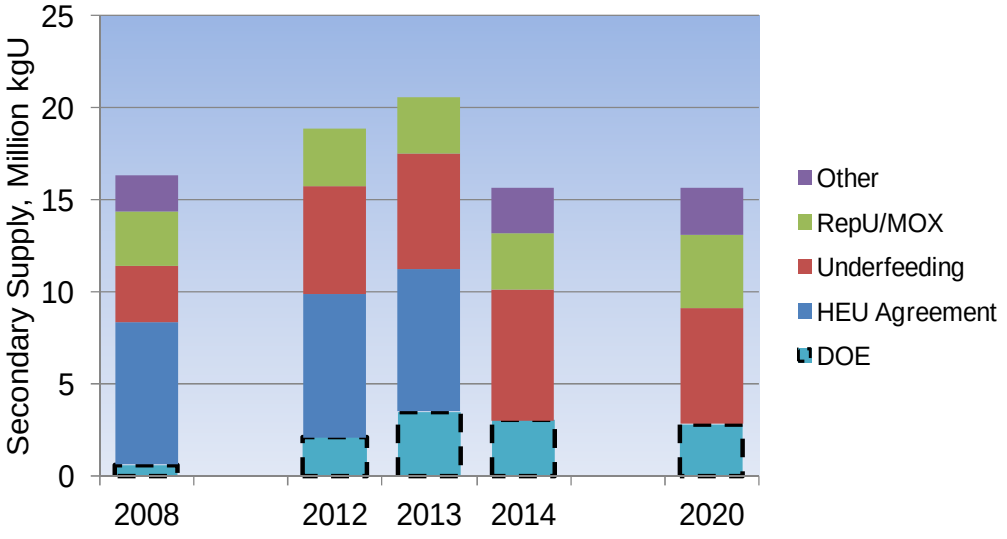


Figure 4.12 DOE Inventory Relative to Total Secondary Supply

Since there is significant industry concern over the impact of DOE inventory on the spot market for uranium, DOE inventory entering the spot market (see Table 3.5) is compared against total spot market volume in Figure 4.13. Note that only DOE spot market entries from 2004 on are shown in the figure. The total spot market volume is taken from Cameco company filings.[31] It is apparent that the DOE material sold on the spot market constitutes just a fraction of total spot market volume, but the fraction has been increased from 1% in 2009 to about 5% in 2010-2012 and 9% in 2013. The DOE material sold on the spot market is expected to remain at levels similar to 2013 for the next ten years.

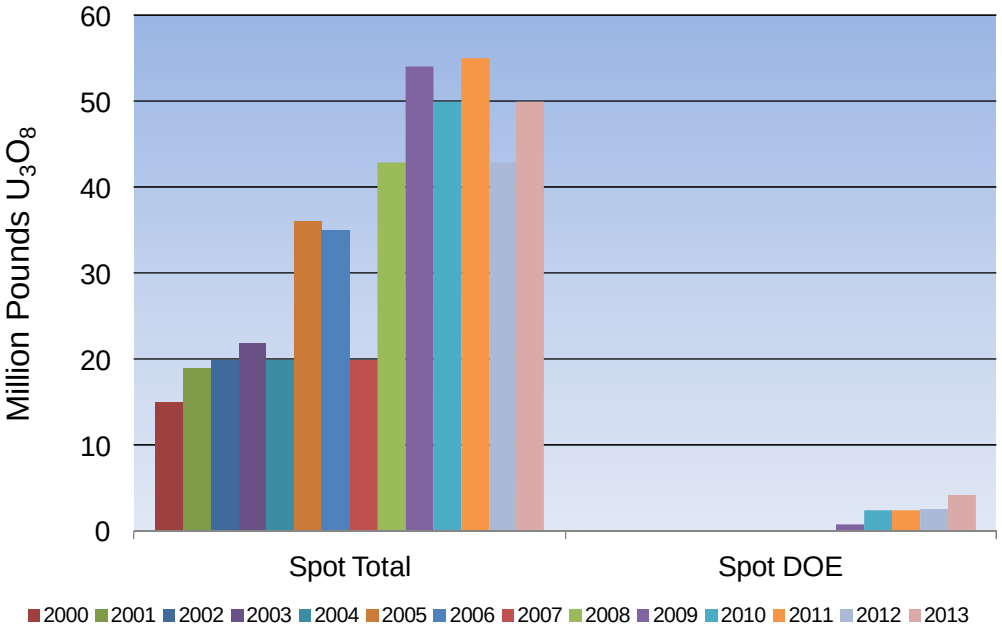


Figure 4.13 DOE Inventory Relative to Spot Uranium Market

DOE Inventory Relative to Other Market Factors

There are many market factors which combine to determine the relationship between supply and demand, and ultimately market prices as found in published price indicators. DOE inventory entering the commercial markets is certainly one of the market factors, but a determination of the DOE inventory's impact must be judged in the context of its relative importance when compared to other market factors. A reasonable judgment on the specific contribution of DOE inventories to observed market price changes can then be made.

[31] February 10, 2014 "Management's Discussion and Analysis" for the year ended December 31, 2013 and similar filings for prior years.

There have been a number of important market factors influencing the markets since DOE inventory entering the commercial markets began to increase with the first barters in December 2009. These factors have affected both supply and demand. The most important factors in addition to the DOE inventory releases are listed below:

- Increased uranium production in Kazakhstan
- Direct demand losses, primarily in Japan and Germany, related to the March 2011 accident at Fukushima Daiichi in Japan
- End of U.S.- Russian HEU Agreement in 2013
- Increase in net demand outside of Japan and Germany
- Changes in secondary supply (other than those associated with DOE inventory), including underfeeding by primary enrichers, upgrades of DUF_6 in Russia
- Net other primary production increases

Figure 4.14 demonstrates how changes in these market factors since 2008 - the year prior to the start of DOE barters - combined to impact the supply / demand balance in 2013. During this period, the uranium market has gone from balanced, with little or no excess supply capacity, to highly over-supplied with considerable excess supply capacity.

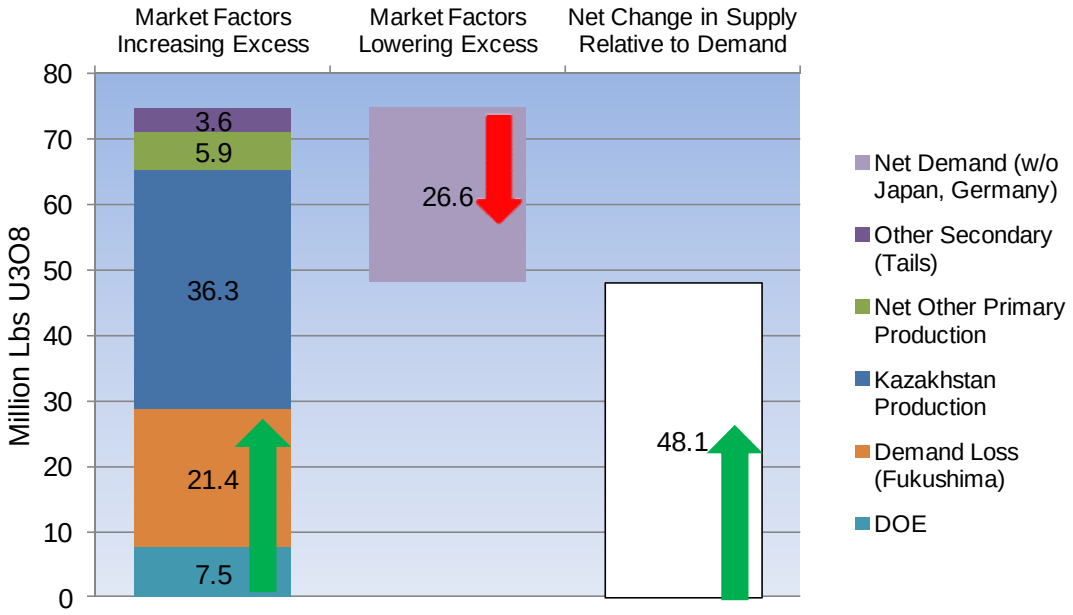


Figure 4.14 Market Factors Contributing to Supply Excess in 2013 Relative to 2008

Figure 4.15 provides a similar comparison of market factors contributing to excess supply for the year 2014 and shows the removal of HEU Agreement feed. The supply excess in 2014 shown in the figure is a conservative value and is probably even larger. Both Figure 4.14 and 4.15 are based on changes in reactor requirements as published by the WNA in

WNA 2013 and reflect a net increase in requirements when Japan and Germany are excluded. However, WNA 2013's requirements for 2014 are optimistic compared to ERI's uranium requirements for 2014. If ERI's estimates of requirements are used instead of WNA's, the supply excess would increase by 6 million pounds. The net change in other secondary supply shown in Figure 4.15 uses the WNA's most recent estimates for underfeeding at enrichment plants, but recent presentations by Urenco[32] and others assume underfeeding in 2014 is even greater than assumed by the WNA. If the larger Urenco value is used, then the 2014 supply excess would increase by 7.5 million pounds.

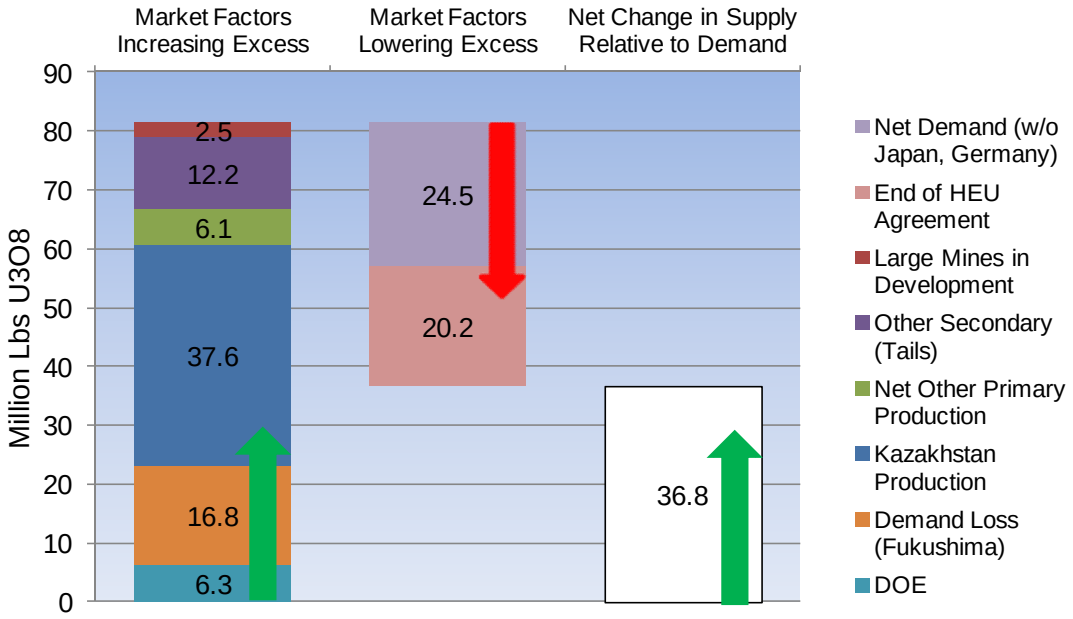


Figure 4.15 Market Factors Contributing to Supply Excess in 2014 Relative to 2008

A key observation which can be drawn from these figures is that the increased supply from the DOE inventory entering the market does not appear to be a primary driver of current excess supply condition. The DOE inventory was responsible for about 10% of the total of all market factors increasing excess supply in 2013, declining to a projected 8% for 2014. If DOE inventory displacing commercial supply had remained at 2008 levels then the net supply excess for 2013 and 2014 would decline by 15% to 20%, but the uranium market would still be considerably over-supplied.

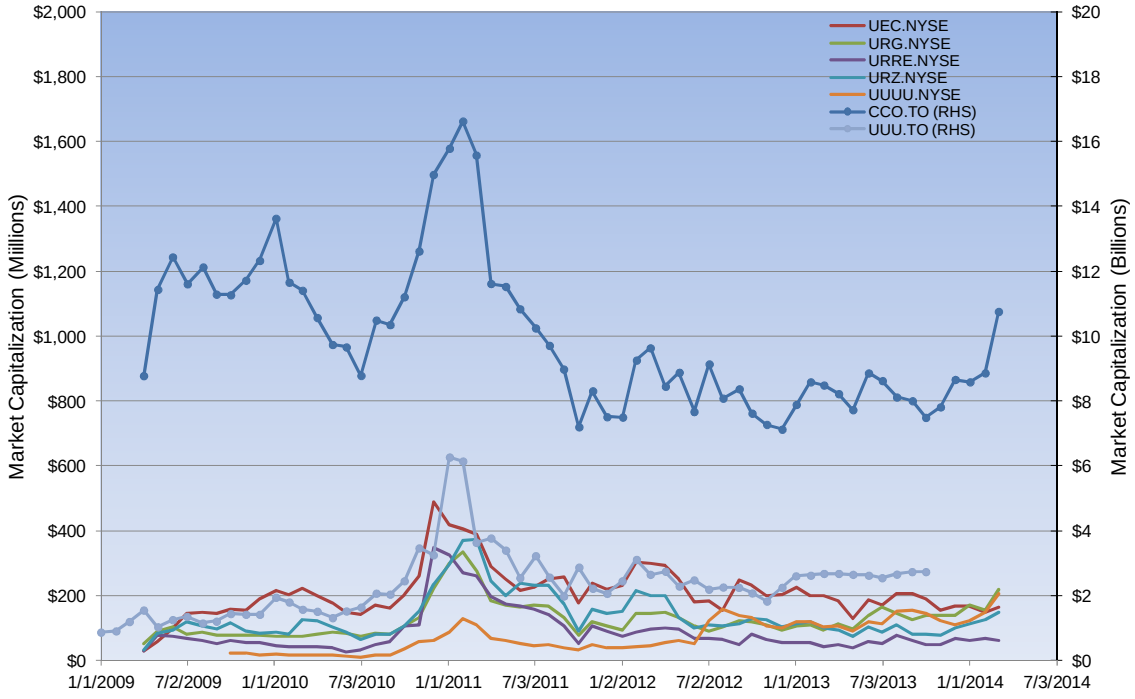
The relative importance of the DOE inventory, compared to other market factors that have contributed to the considerable excess inventory that exists today, indicates that the DOE

[32] Harding, Paul, Executive Director Commercial, Urenco, "Uranium Enrichment - Update From Urenco", World Nuclear Fuel Market, Istanbul, Turkey, June 2013. Total uranium supply from underfeeding put at 10,000 MTU, equivalent to 26 million pounds U_3O_8 per year.

inventory can only be considered responsible for a portion of the decline in market prices observed since the Fukushima event. This conclusion is consistent with the impacts on market price developed in Section 4.1.

Market Capitalization

For the smaller mining companies in the U.S., most of which are publicly traded, market capitalization[33] is an important metric. Figure 4.16 displays the market capitalization history of companies[34] with U.S. production. Two of the companies, Cameco and Uranium One, are quite large with market capitalization in the billions, while the remaining companies are smaller with market capitalization in the millions. Two scales are therefore provided in the figure, with the larger companies using the right hand scale and the smaller companies using the left hand scale.



Source: www.ycharts.com

Figure 4.16 Market Capitalization of Companies with U.S. Production

The data is compared on a relative basis, where each company's market capitalization in December 2009 equals 100, in Figure 4.17. Also provided in the figure are the spot and term market price indicators, which use the right hand scale. It is observed that the market capitalization of the smaller mining companies is sensitive to changes in the spot market

[33] Share price multiplied by number of outstanding shares.

[34] The companies are identified by their ticker symbols and stock market exchange in the figure.

price. During 2010, spot price increased from $40 per pound up to $70 per pound, an increase of 75%. The market capitalization of the smaller U.S. miners increased 150% to 600% in response. The response of a large mining company, Cameco, was restrained in comparison, with market capitalization increasing about 75%. Figure 4.17 shows that market capitalization declined just as rapidly following the Fukushima event. It is of interest to note that the market capitalizations have been increasing during the last six months even though market prices have not.

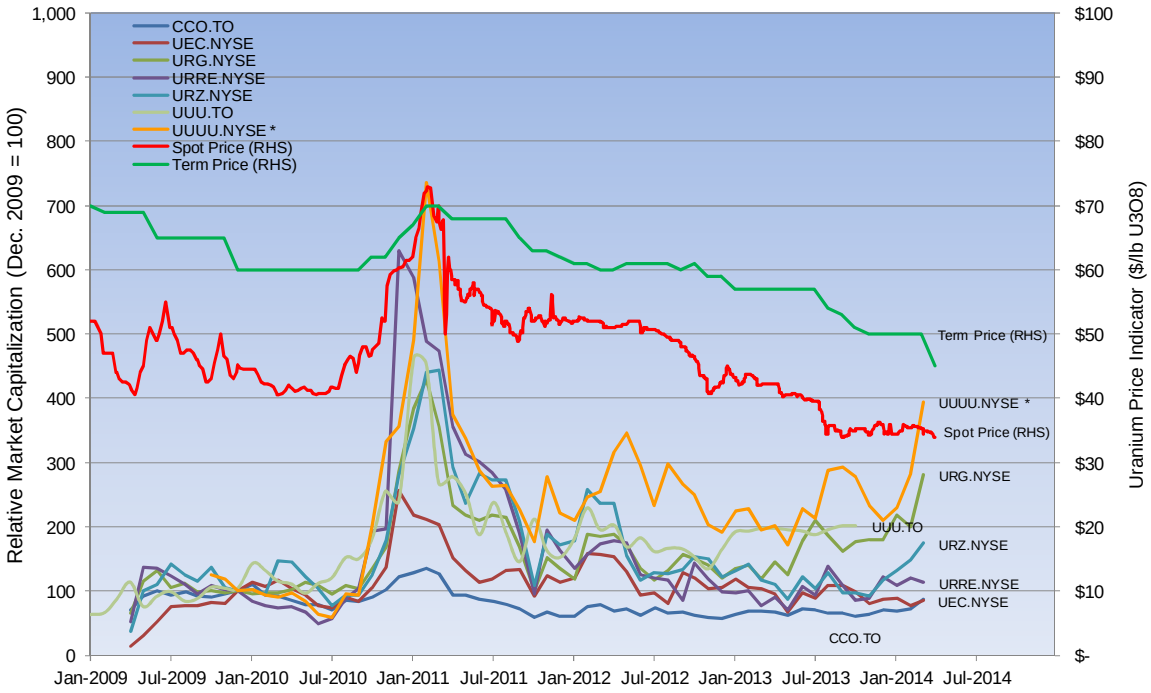


Figure 4.17 Market Capitalization -- Relative to December 2009

Market capitalization is an important metric for the smaller, publicly traded mining companies in the U.S. because it is representative of the ability of these companies to raise funds needed to move projects through the licensing process, which can take many years, as well as initial project development in some cases. The smaller companies generally do not have easy access to debt financing and are more dependent on equity financing. While the impact of large changes in the spot market price is obvious, the effect on market capitalization from the smaller price changes attributed to DOE inventory entering the market (See section 4.1) is not as clear.

Realized Prices and Production Costs

Revenues from U.S. uranium sales are obtained under a mix of term and spot market price based contracts. This is demonstrated by Figure 4.18, which compares the EIA's average delivered price in the U.S. with historical market prices. The figure shows that for U.S.

end-users, the average price of all delivered uranium has increased steadily over the past ten years, before leveling off in 2012. A small decline is expected by ERI for 2013. The EIA average delivered price in the U.S. is representative of realized prices for the uranium industry on a global basis.

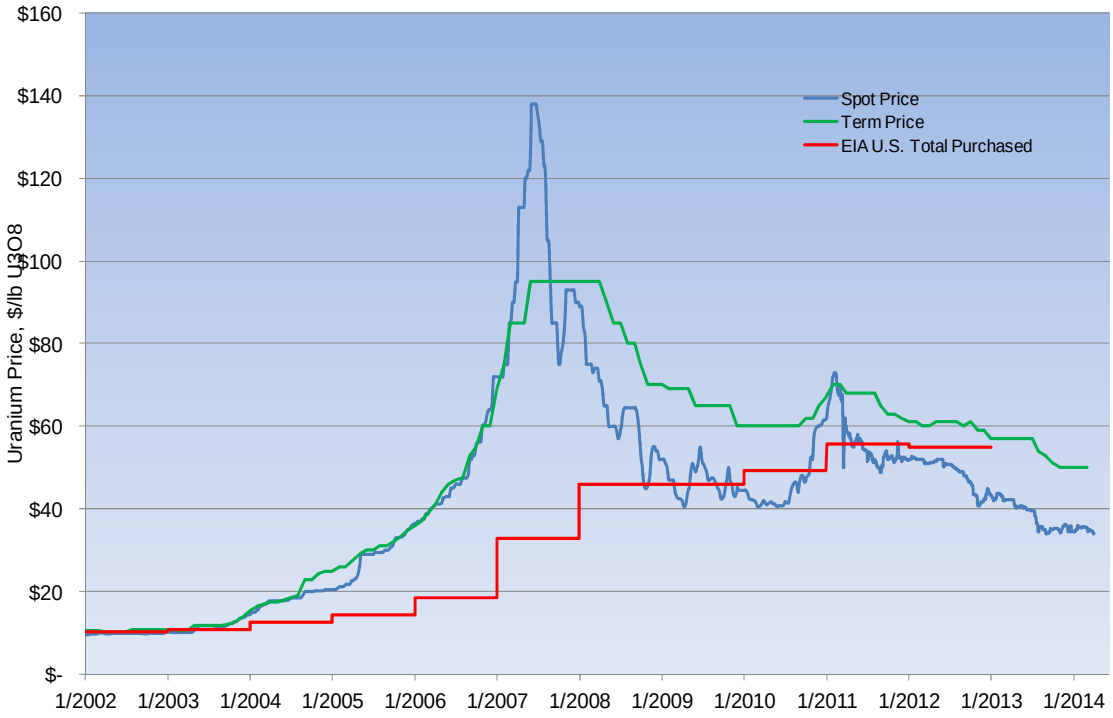


Figure 4.18 Market Prices and Average Delivered Price in the U.S.

Realized prices for the U.S. uranium supply industry varies from one company to another, as demonstrated by Figure 4.19 which presents the realized prices for companies with U.S. production during the period 2011 to first quarter of 2014. The prices are drawn from company public filings[35], and are compared to the average spot market price for each year. It is apparent that some mining companies have chosen to sell on a spot market price basis, while others have hedged their exposure to the spot market by locking in prices using a base price escalated approach for a portion of their portfolio. For example, Cameco - the largest U.S. producer - has reported that it usually includes in its contracts a mix of fixed-price and market-price components, which reflect a target of 40% fixed-price and 60% market-price**.** The companies providing price data represent approximately 95% of U.S. production in 2013. Less than 30% of the production came from companies that were effectively unhedged (no long-term contracts with higher fixed prices)[36].

[35] Note that Cameco's prices are for all production, not just the U.S. based production.

[36] Note that while Uranium One's realized price for U.S. production does not demonstrate a strong sensitivity to spot price, the company as a whole does and so Uranium One has been categorized as not hedging with fixed price contracts.

Cameco estimates the price sensitivity of its current contract portfolio for sales of uranium relative to change in future spot market price.[37] Cameco's most recent estimate indicates that the projected change in realized price is about 50% of the change in spot market price during 2014 to 2018. For example, if the spot market price were to change by $5.00 per pound, then this means that Cameco's realized price would change by $2.50 per pound.

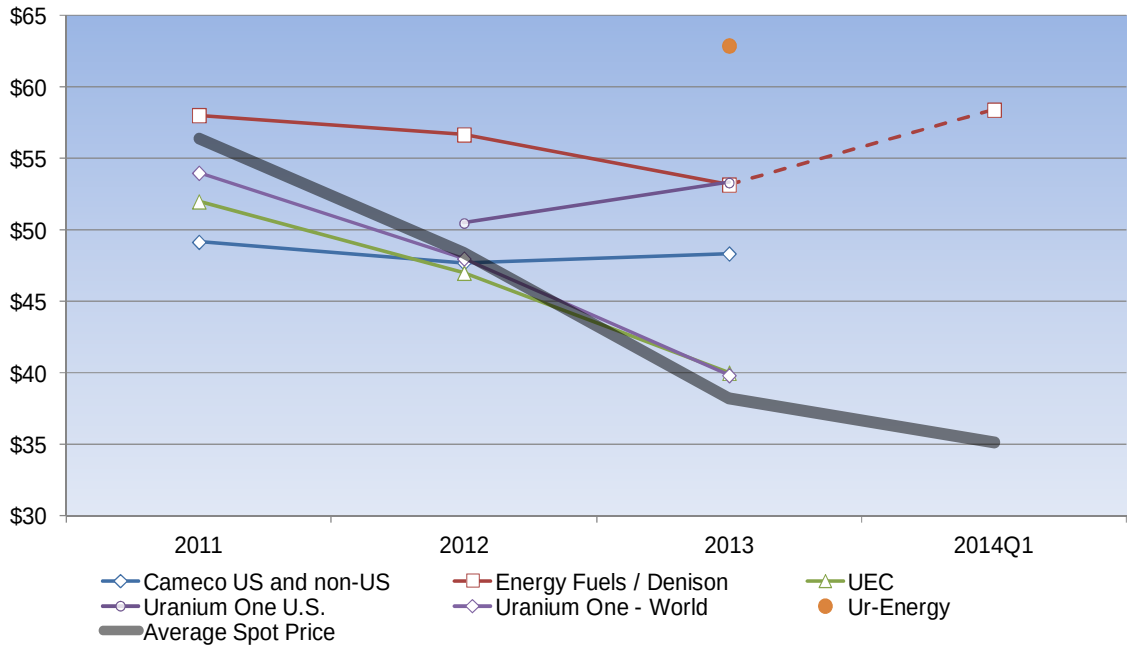


Figure 4.19 Realized Uranium Prices of Companies with U.S. Production

It is apparent that new U.S. uranium producers that have recently begun production have used fixed price term contracts to support the startup of their operations. Figure 4.20 shows that these companies agreed to such contracts when long-term prices were in the $55 to $70 per pound range. These contracts have allowed the new operations to follow through on facility development even as prices have declined over the past one to two years. At least one of these companies has stated that the project would not have been able to proceed if the initial contracts had been made at current price levels ($45 to $50 per pound long-term). Owners of proposed new conventional mines outside the U.S. have typically stated that a price of $65 to $70 per pound is required to move forward with development.

It does not appear that removing the DOE inventory from the market and adding back the $2 to $3 per pound price impact attributed to the DOE inventory material (shown in Table 4.1) would necessarily increase current prices enough to change the situation regarding the viability of new production centers in the U.S., that is, current spot prices would remain under $40 per pound and current term prices would remain under $50 per pound - levels

[37] Cameco Corporation in its February 10, 2014 "Management's Discussion and Analysis" that accompanied its financial statement and notes for the year ended December 31, 2013.

significantly below the price signal required to move forward with the development of a new mine in the U.S. In the current oversupplied market which is trending down, ERI would observe that the entry of any material to the spot market has tended to cause further erosion of spot market price, while the removal of material from the market has not resulted in an increase in price.

Figure 4.20 also shows the price levels when announcements of cutbacks were made by some U.S. suppliers. Energy Fuels put its conventional mines in Utah on standby when spot prices dropped below $45 per pound. Uranium One and UEC cut back production activity at their in-situ-leach (ISL) facilities when spot prices dropped below $40 per pound. With spot prices in the $35 range, Energy Fuels announced its decision to place its remaining conventional mines still in operation and the White Mesa mill on standby for a year.

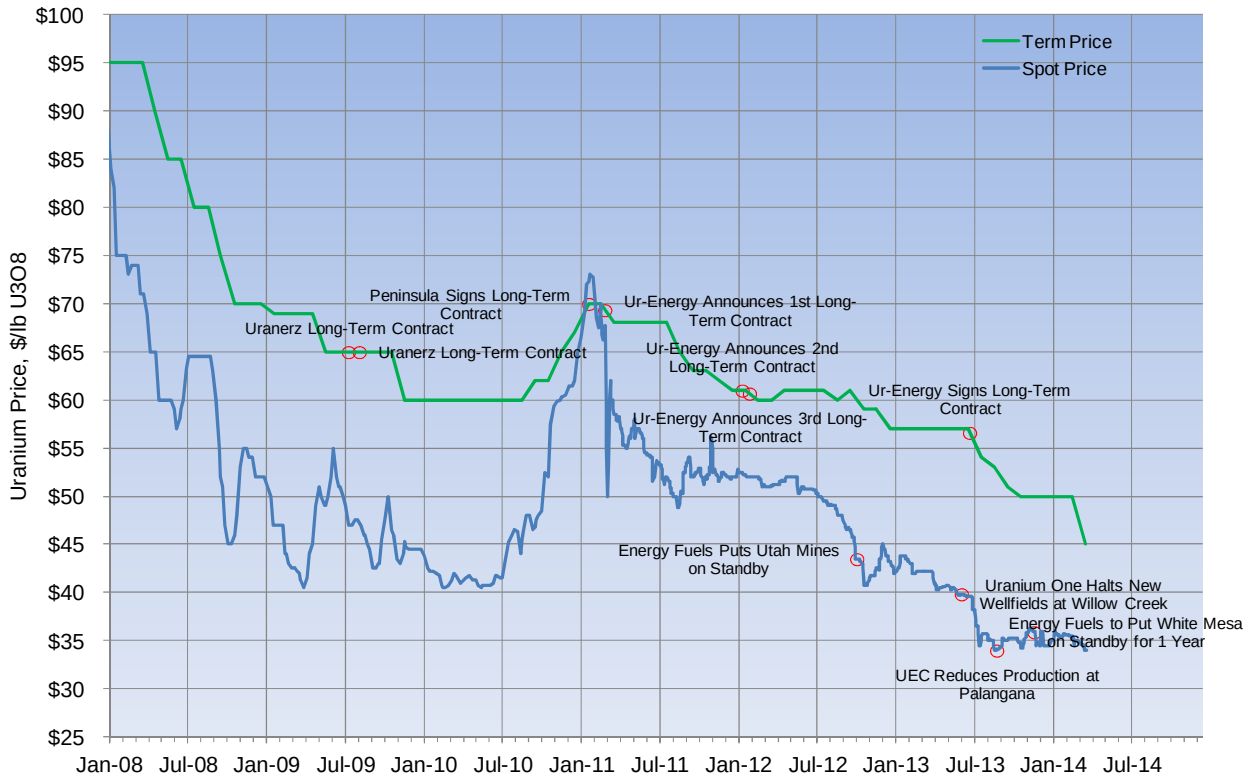


Figure 4.20 Market Prices and U.S. Industry Contracting and Production Events

U.S. uranium producers also report costs in company filings, but there is some variation in the type of cost information reported. Most companies report a cash operating cost, which ranges between $15 and $30 per pound for ISL facilities. This cost may be on a per pound produced or pound sold basis and generally does not include royalties and severance taxes, which are based on realized price. To get a true production cost, depreciation of initial plant costs must be added. More importantly, ISL facilities require the constant development of new wellfields in order to maintain output level, otherwise production will

fall off over a period of several years. The treatment of initial and ongoing capital costs vary, but need to be taken into account. They are capitalized and amortized in some cases and expensed in the year incurred in other cases. Such capital costs are generally not included in reported cash operating cost, but in some cases these costs are included. The ongoing wellfield development typically adds about $10 per pound produced. Production costs for U.S. ISL facilities are in the low $30s to mid $40s per pound range, which is consistent with the timing of decisions to cut back as shown in Figure 4.20. Some of these facilities employed contracting strategies which are immediately sensitive to changes in spot price. As a result, operations were cut back as prices declined to $40 per pound and below. The production-weighted average production cost in the U.S. is estimated to be about $40 per pound. According to other market analysts this is similar to the global average production cost and consistent with statements that about one-half of world production is at costs above the current spot market price.

The EIA reports total industry expenditures for U.S. uranium production, including facility expense, in its annual Domestic Uranium Production Report. The total for 2012 was $187 million, or an average of $45 per pound when spread across 2012 uranium production of 4.15 million pounds in 2012. These costs have been rising, as shown in Figure 4.21. It appears that the costs reported to the EIA may include the immediate expensing of initial development costs rather than depreciation of these costs over the facilities life.

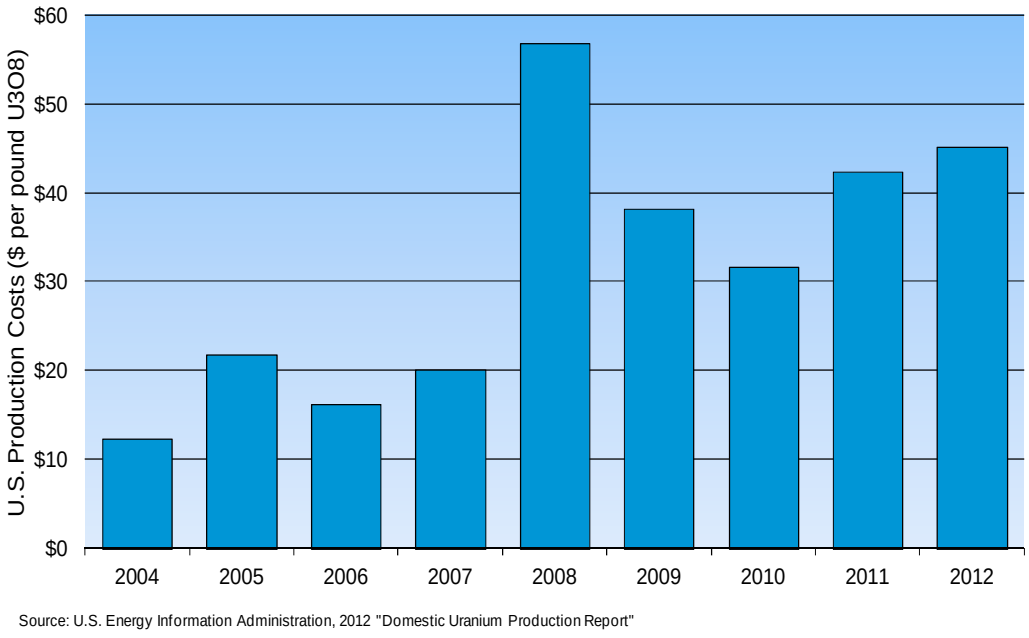


Figure 4.21 EIA Production Costs for U.S. Industry

It is not clear that adding back the $2 to $3 per pound price impact attributed to all DOE inventory material earlier in this section (shown in Table 4.1) would move current prices

enough to cause these facilities to ramp wellfield development and production activities back up. The resulting price level of $36 to $37 per pound would remain less than $40 and may still not be sufficient for some ISL producers to restart wellfield development activities, and likely would not have prevented the decisions to cut back

If market prices remain at the current depressed levels for several years, which seems to be the consensus view of many in the industry, then more U.S. production will be impacted and may be put on standby, as existing longer term contracts at higher prices are completed and can only be replaced by new, lower-priced contracts.

Predictability

The DOE's intent to release (commercialize) its excess inventories have been known to the market for a long time. The supply industry has generally requested that the inventories be released to the market in a predictable and transparent manner, thereby allowing the industry to plan and make investment decisions accordingly. In a March 2008 policy statement, DOE introduced a guideline that the inventory that it released into the commercial nuclear fuel market would be below 10% of U.S. requirements for nuclear fuel. The guideline also allowed additional material to be released to support first cores for new nuclear power plants. Figure 4.22 displays how DOE's planned inventory releases have changed since the 2008 Plan. The figure shows a range of material expected to be released as contained in the 2008 Plan, with the shaded area representing the potential supply of first cores for new U.S. reactors. The actual number of new U.S. reactors under construction has been less than anticipated in the 2008 Plan. The grey line in Figure 4.22 represents the reduced first core needs in the U.S., even though these first cores were not directly supplied by DOE. The composition of the DOE inventory that has been released to the commercial market has changed, with less DUF_6 and more natural UF_6 released so far. The actual quantities of DOE inventory entering the market were generally consistent with the 2008 Plan as adjusted for reduced first cores through 2012.

A major change did occur with the May 2012 Determination, which resulted in an increase in the barter quantities by 800 MTU (2.1 million pounds U_3O_8 equivalent) per year. This change took place just one year after a 2011 Determination which did not account for the increase. The limited notice and increase in quantity released represented a lack of predictability to the domestic uranium industry.

The inventory release schedules that DOE specified for use in this 2014 market impact analysis are consistent with the May 2012 Determination through the year 2020. This 2014 market impact study includes the potential impact of the release of additional DUF_6, which is currently under negotiation. In the RFO regarding DUF_6 inventory, DOE specified that no natural uranium equivalent from the DUF_6 could enter the market before 2019, and 2020 appears to be the earliest the material could enter the market.

DOE now appears to be making an effort to maintain the predictability of its inventory releases. The DOE 2013 Plan provided additional details on the size and composition of its

excess inventories and the planned releases of additional DUF_6 have been announced many years in advance of actual release. While DOE may need to increase the quantity of NNSA barters, it plans to lower the EM barters to compensate so that the total quantity released is consistent with the DOE 2012 Plan.

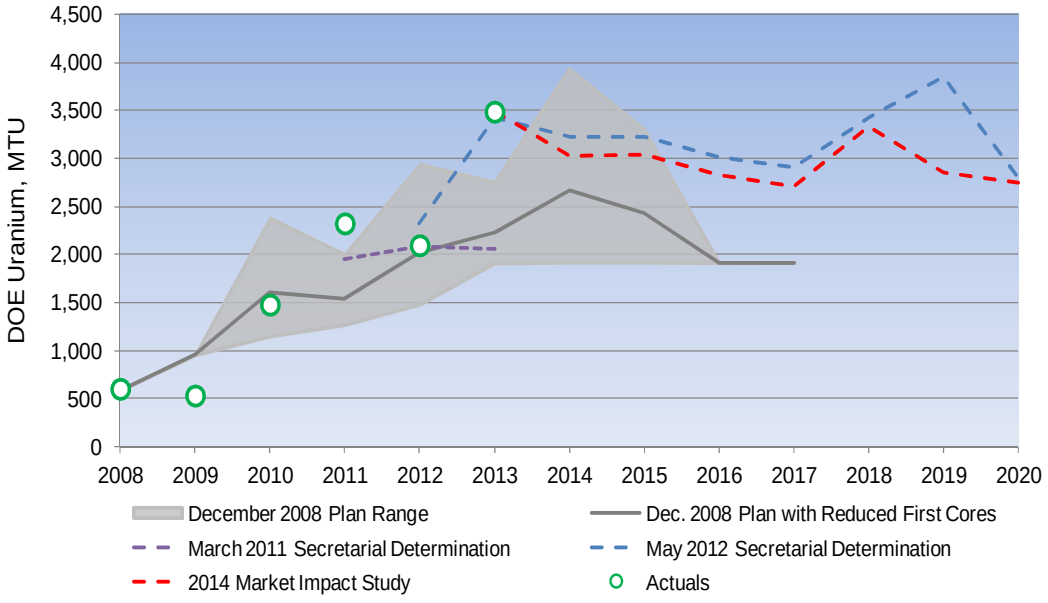


Figure 4.22 Changes in DOE Inventory Release Plans

Summary of Uranium Market Impacts

A summary of key observations regarding the impact of DOE inventory entering the commercial markets is provided below:

- The global uranium, conversion and enrichment industries are all in a state of considerable over-supply. The current over-supply in the uranium market is due to both increases in primary and secondary supply sources as well as Fukushima-related demand loss. The DOE inventory is equivalent to about 10% of the total of all factors increasing supply excess and less than 20% of the current net supply excess. The over-supply would remain large even if no DOE inventory entered the current uranium market.
- Market prices have declined considerably (-50% spot and -35% term) since the Fukushima event three years ago and from the levels at the time of the May 2012 Determination (-34% spot and -25% term).

- The price impact attributed to DOE inventory entering the uranium market averages $2.8 per pound over the next ten years. This is equivalent to 8% of the current spot price and 6% of the current term price.

- Industry employment, as reported by the EIA, has increased between 2009 and 2012, but declines are expected for 2013 and 2014. Employment losses due to cut-backs at a number of existing production centers have occurred during the last 18 months, but are partially offset by increases due to the start up of several new production centers. Employment in the exploration sector has declined. Net job loss during 2013 and 2014 combined is estimated at about 210 person-years. The estimate of the impact of DOE releases on industry employment over the next ten years is 40 to 50 person-years, about a 4% decline from estimated employment levels without DOE inventory releases.

- Industry production has increased through 2013, with further increase expected in 2014.

- The number of uranium production centers in operation in the U.S. has increased through 2013, with further increase expected in 2014. However, some U.S. production centers have been or plan to be put on standby. The new production is supported by term-contracts with higher prices. Current prices do not support new development.

- The predictability of DOE inventory releases into the nuclear fuel markets is a major concern for the supply industry, but has been mixed in the past. It is noted that the quantities being evaluated in this 2014 market impact study are consistent with the 2013 DOE Plan and the May 2012 Determination. In terms of predictability, this is only one data point but it represents an improvement.

- Announced cut-backs at existing global primary supply the past 12 to 18 months total close to 5 million pounds U_3O_8[38] per year. Primary supply for 2014 is also expected to be lower due to outages resulting from tank leaks at Rio Tinto mines in Namibia and Australia. While the ultimate impact on Rio's 2014 production is not yet known, it is likely to be several million pounds at least. In total, these reductions in primary supply for 2014 are roughly equivalent to the DOE inventory contribution to 2014 supply, but have not resulted in higher prices.

- While the current over-supplied market does not appear to be very sensitive to supply withdrawals so far, spot market prices are quite sensitive to additional supply.

- The supply industry believes DOE should consider the current oversupplied market, in which an increasing portion of U.S. production will be exposed to low market prices, when determining the appropriate quantity of DOE inventory to enter the market.

[38] Announcements have been made for Kayelekera, Honeymoon, Willow Creek, several Energy Fuels mines, Palangana

4.2.2 Potential Impact on the Domestic Conversion Services Industry

While DOE transfers would not displace already committed sales, a July 2012 presentation by a Converdyn official noted that, as a result of plant closures in Japan and Germany following the March 2011 Fukushima accident in Japan, Converdyn experienced a 25% loss of volume in sales.[39] World demand for conversion services associated with the loss of volume from Japan and Germany is estimated to be 9.5 million kgU of UF_6, or 15-16% decrease in total world conversion requirements. In a published review of the 2012 ERI Report (2012 Converdyn Review), Converdyn noted that "*for the domestic conversion industry the loss of production volume to DOE sales has the potential to have other adverse material impacts which have not been addressed.*"[40] In the analysis described below, because there is only one uranium conversion facility in the U.S., the loss of sales/production volume for Converdyn that is associated with the entry of DOE material into the conversion market can be assessed. In this analysis, ERI considers Converdyn's reported 25% loss of volume associated with post-Fukushima losses in Japan and Germany.

Analysis of Sales Volume Impact

In the 2012 Converdyn Review, Converdyn states that the 2 million kgU as UF_6 associated with the entry of DOE material into the conversion market would impact Converdyn's sales volumes, resulting in an increased cost per kgU of 20%. According to the document, this 2 million kgU is an approximate average volume of DOE material that enters the market annually based on a table in 2012 ERI Report.

The assumption that 100% of the DOE material that enters the conversion market in a given year will impact Converdyn's sales volumes (or any one converter's sales volumes) does not reflect the varying market shares held by the various converters. The U.S. market utilizes conversion services (or UF_6) from all four of the world producers, as well as secondary market material from brokers and traders. The conversion component may also be provided as part of EUP, whether from a fully integrated enricher or from an enricher underfeeding.

Converdyn does not publish its annual production volumes of UF_6. However, ERI analysis of the conversion market, as well as communication regarding contract terms and pricing that Converdyn sent to its customers in 2010, indicate that Honeywell's Metropolis Works produced an average of 10 million kgU as UF_6 annually during the prior four years. While there were performance improvements between 2009 and 2011[41], subsequently, Metropolis

[39] Mani, Ganpat, President and CEO, Converdyn, *Review of Study Supporting Accelerated DOE Inventory Sales and Transfers*, Nuclear Energy Institute, Nuclear Fuel Supply Forum, Washington, DC. July 31, 2012.

[40] Critchley, Malcolm, Chris Frankland and Ganpat Mani, Converdyn, *Review of the ERI Study used to Support the May 15, 2012 DOE Secretarial Determination for the Sale or Transfer of Uranium*, June 2012 (2012 Converdyn Review), p. 1.

[41] Mani, Ganpat, Converdyn, Navigating to the Land of Secure Conversion Supply, World Nuclear Fuel Market, 2011, Seville, Spain, June 2011, p. 6.

works was shut down for maintenance and seismic upgrades for much of 2012 and 2013.[42] While the nameplate capacity of Metropolis Works is 15 million kgU as UF_6, for the purposes of analyzing the potential loss of sales volume to Converdyn associated with the introduction of DOE inventory into the market, ERI examines two cases: (1) production at 10 million kgU per year and (2) production at 12 million kgU per year prior to Converdyn's stated 25% loss of volume associated with customers in Germany and Japan following the Fukushima accident. Thus, assuming a 2010 production volume of 10 million kgU and a 25% loss of this volume, Converdyn's current sales volume would be 7.5 million kgU. Likewise, assuming a 2010 production volume of 12 million kgU, with a 25% loss of sales volume, Converdyn's 2014 sales volume would be 9 million kgU.

In order to illustrate the impact on the conversion market associated with entry of DOE inventory, ERI analyzes the impact of the entry of planned DOE inventories totaling 3.023 million kgU in 2014, as shown in Table 4.4. This value is indicative of the entry of planned DOE inventories over the next seven years, and is somewhat higher than the average 2.5 million kgU of planned DOE inventory expected to enter the market over the next 20 years (2014 to 2033). (See Table 3.4) The DOE inventory that will enter the market in 2014 includes: 0.65 million kgU from allocated downblended HEU, 2.06 million kgU associated with EM barter material to support GDP cleanup, and 0.32 million kgU associated with downblended off-spec HEU previously transferred to TVA. For the purpose of this analysis, ERI assumes that 100% of the allocated downblended HEU and 100% of the material transferred to TVA will enter the U.S. market.

The material associated with EM barters is provided to Fluor B&W Portsmouth (FBP) to cover the cost of cleanup of the GDPs. In May 2011, FBP entered into an agreement with Traxys North America LLC (Traxys) for the purchase of the FBP material. According to Traxys, 50% of the FBP material is sold to U.S. utilities and 50% to non-U.S. utilities, and 50% of sales are under mid- and long-term contracts. Traxys also notes that some U_3O_8 and conversion have been contracted separately.[43] As shown in Table 4.4, ERI assumes that 50% of the EM barter material enters the U.S. market and 50% enters the remaining world market. Thus, out of the total of 3.02 million kgU of DOE inventory expected to enter the market in 2014, an estimated 2 million kgU, or 66% is expected to be sold into the U.S. market and 1.03 million kgU, or 34% is expected to be sold into the remaining world market.

[42] While Metropolis Works was shut down for maintenance and seismic upgrades from May 2012 to July 2013, shipment of UF_6 to customers under existing contacts was able to continue. The shutdown itself should not have impacted Converdyn sales volumes in 2012 and 2013. However, future sales may have been impacted due to a combination of uncertainty surrounding the schedule for restart of Metropolis Works and then-current low market price.

[43] Smith, Kevin, Director Uranium Trading and Marketing, Traxys, Commercial View of DOE's 2013 Plan for Natural Uranium Barter Sales, Nuclear Energy Institute, International Uranium Fuel Seminar, October 6-9, 2013, San Antonio, Texas.

Material Description	2014 Quantity	Volume to U.S. Market		Remaining Volume to World Market	
		%	Quantity	%	Quantity
Allocated HEU Downblend	0.65	100%	0.65	0%	0.00
EM Barters for GDP Cleanup	2.06	50%	1.03	50%	1.03
Off-Spec HEU Downblend - TVA	0.32	100%	0.32	0%	0.00
Total	3.02	66%	2.00	34%	1.03

Table 4.4 Summary of DOE Inventory Expected to Enter the Conversion Market in 2014

As shown in Table 4.5, world requirements for natural uranium as UF_6 in 2010 were approximately 60.3 million kgU. In 2010, U.S. requirements were 19.2 million kgU and requirements in Japan and Germany were 7 million kgU and 2.5 million kgU, respectively. Requirements in China and Russia in 2010 were 3.9 million kgU and 6.7 million kgU respectively. According to Converdyn statements, it does not have access to the markets in Russia and China. If natural uranium requirements for Russia/CIS and China are removed from total world requirements, the remaining world requirements in 2010 were 49.7 million kgU. Total world demand for natural uranium in 2014 is estimated to be 60 million kgU. Taking into account the reduced demand for uranium in Germany (1.8 million kgU) and Japan (0 kgU), the remaining world requirements in 2014 are estimated to be 44.4 million kgU. U.S. requirements in 2014 are an estimated 20 million kgU.

Regional Market	2010	2014
World	60.3	60.0
U.S.	19.2	20.0
Japan	7.0	0.0
Germany	2.5	1.8
China	3.9	6.0
Russia/CIS	6.7	9.6
Remaining World - Russia/CIS & China	49.7	44.4

Table 4.5 World and Regional Requirements for Natural Uranium (UF_6) in 2010 and 2014

Converdyn does not publish information regarding its share of the world market for conversion services (U.S., Europe, Asia, etc.) Based on ERI analysis of the world market for conversion services that utilizes publicly available information regarding market share

from the other three primary converters, ERI has determined that Converdyn has an estimated 25% share of the U.S. market for conversion services, or approximately 5 million kgU in sales volume for Converdyn. ERI also examines the impact associated with a higher Converdyn market share of the U.S. market – 30% (6 million kgU in 2014). Assuming a 25% Converdyn share in U.S. market results in a U.S. sales volume of 5 million kgU (20 million kgU * 25%). If Converdyn's 2014 sales volume is 7.5 million kgU (assuming a 25% loss of sales on pre-Fukushima volume of 10 million kgU), this means that 2.5 million kgU are allocated to the remaining world market minus the U.S. market (44.4 million kgU – 20 million kgU), or an estimated 10% market share as shown in Table 4.6.

Converdyn Market Share Assumption		Converdyn Share of Market Share		Market Volume Impact to Converdyn (million kgU)			Converdyn Volume (million kgU)	
		US	Remaining World (1)	US	Remaining World	Total	With DOE Inventroy	Without DOE Inventory
		%	%					
Assuming US Market Share of 25% (2)	Low	25%	10%	0.50	0.11	0.60	7.50	8.10
Assuming US Market Share of 30% (3)	High	30%	6%	0.60	0.06	0.66	7.50	8.16

Note (1): For purposes of the calculation of Converdyn's share of World market, ERI assumes World Market of 44.4 million kgU as UF6 (World minus US market minus Russia/CIS and China)

Note (2) : U.S. market share of 25% is based on ERI calculations, given publicly available informaton for other primary converters. Calculations assume pre-Fukushima market volume of 10 million kgU for Converdyn, and post-Fukushima volume of 7.5 million kgU (25% loss of volume according to Converdyn statements. Remaining World market Share (minus Russia/CIS and China requirements) = 7.5 - (.25)(20 m kgU - US market) / 44.4 (wold market - Russia/China) - 20 (US market)

Note (3): U.S. market share of 30% is an estimate to provide an upper bound.

Table 4.6 Impact on Converdyn Market Volume Associated with Introduction of DOE Inventory into the Market in 2014, Assuming Pre-Fukushima Sales Volume of 10 Million kgU as UF_6

Applying Converdyn's U.S. market share of 25% and the remaining world market share of 10% to the volume of DOE inventory expected to be introduced into the market in 2014 from Table 4.5, results in a volume impact of 0.5 million kgU in the U.S. market and 0.11 million kgU impact in the remaining world market for a total of 0.6 million kgU. As discussed above, assuming that Converdyn's post-Fukushima sales volume is 7.5 million kgU, Converdyn's market volume without the introduction of DOE inventory to the market would be 8.1 million kgU as UF_6 as shown in Table 4.6. Similarly if Converdyn has a 30% share of the U.S. market, then there would be a 0.6 million kgU volume impact in the U.S. market and a volume impact of 0.06 million kgU in the remaining world. Thus, Converdyn's market volume without the introduction of DOE inventory to the market would be 8.16 million kgU as UF_6 as shown in Table 4.6.

Figure 4.23 compares Converdyn's pre-Fukushima sales volumes with its post-Fukushima sales volume, including the 0.6 to 0.66 million kgU impact to its sales volume associated

with the introduction of DOE material into the market in 2014. This 0.6 to 0.66 million kgU is equal to a 7.5% (0.6 / 8.1) to 8.1% (0.66/8.16) reduction in sales volume due to the introduction of DOE inventory into the market.

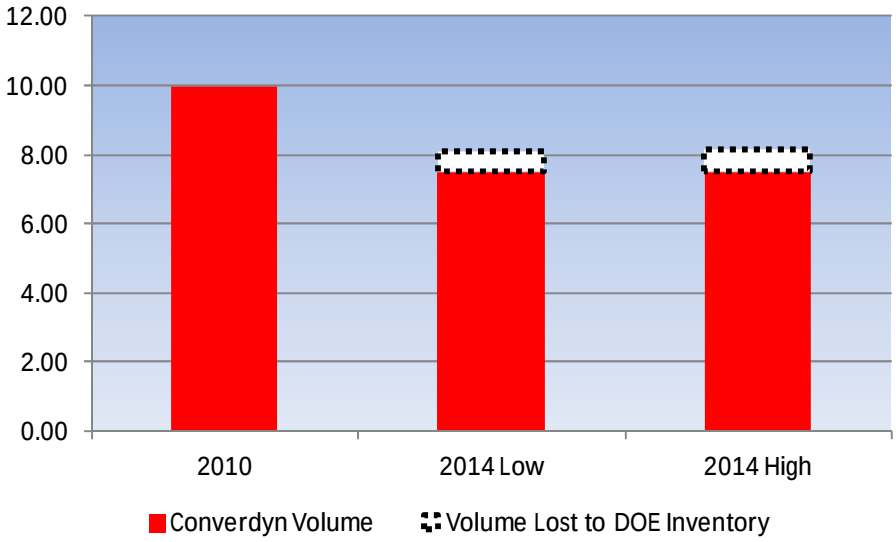


Figure 4.23 Estimated Converdyn Sales Volume in 2010 and 2014, Volume Impact of DOE Sales in 2014 Assuming Pre-Fukushima Sales Volume of 10 Million kgU as UF_6

The impact on Converdyn's sales volume was also analyzed assuming that Converdyn had a pre-Fukushima sales volume of 12 million kgU. Assuming a 25% Converdyn share in U.S. market results in a U.S. sales volume of 5 million kgU (20 million kgU * 25%). If Converdyn's 2014 post-Fukushima sales volume is 9 million kgU (assuming a 25% loss of sales on pre-Fukushima volume of 12 million kgU), this means that 3 million kgU are allocated to the remaining world market minus the U.S. market (44.4 million kgU – 20 million kgU), or an estimated 12% market share as shown in Table 4.7.

Converdyn Market Share Assumption		Converdyn Share of Market Share		Market Volume Impact to Converdyn (million kgU)			Converdyn Volume (million kgU)	
		US	Remaining World (1)	US	Remaining World	Total	With DOE Inventroy	Without DOE Inventory
		%	%					
Assuming US Market Share of 25% (2)	Low	25%	16%	0.50	0.17	0.67	9.00	9.67
Assuming US Market Share of 30% (3)	High	30%	12%	0.60	0.13	0.72	9.00	9.72

Note (1): For purposes of the calculation of Converdyn's share of World market, ERI assumes World Market of 44.4 million kgU as UF6 (World minus US market minus Russia/CIS and China)

Note (2) : U.S. market share of 25% is based on ERI calculations, given publicly available informaton from other primary converters. Calculations assume pre-Fukushima market volume of 12 million kgU for Converdyn, and post-Fukushima volume of 9 million kgU (25% loss of volume according to Converdyn statements. Remaining World Market Share = 9 - (.25)(20 m kgU - US market) / (44.4 (world market - Russia/China) - 20 (US market))

Note (3): U.S. market share of 30% is an estimate to provide an upper bound.

Table 4.7 Impact on Converdyn Market Volume Associated with Introduction of DOE Inventory into the Market in 2014, Assuming Pre-Fukushima Sales Volume of 12 Million kgU as UF_6

Applying Converdyn's U.S. market share of 25% and the remaining world market share of 10% to the volume of DOE inventory expected to be introduced into the market in 2014 from Table 4.4, results in a volume impact of 0.5 million kgU in the U.S. market and 0.17 million kgU impact in the remaining world market for a total of 0.67 million kgU. Assuming that Converdyn's post-Fukushima sales volume is 9 million kgU, Converdyn's market volume without the introduction of DOE inventory to the market would be 9.67 million kgU as UF_6 as shown in Table 4.7. Similarly if Converdyn has a 30% share of the U.S. market, then there would be a 0.6 million kgU volume impact in the U.S. market and a volume impact of 0.13 million kgU in the remaining world. Thus, Converdyn's market volume without the introduction of DOE inventory to the market would be 9.72 million kgU as UF_6 as shown in Table 4.7.

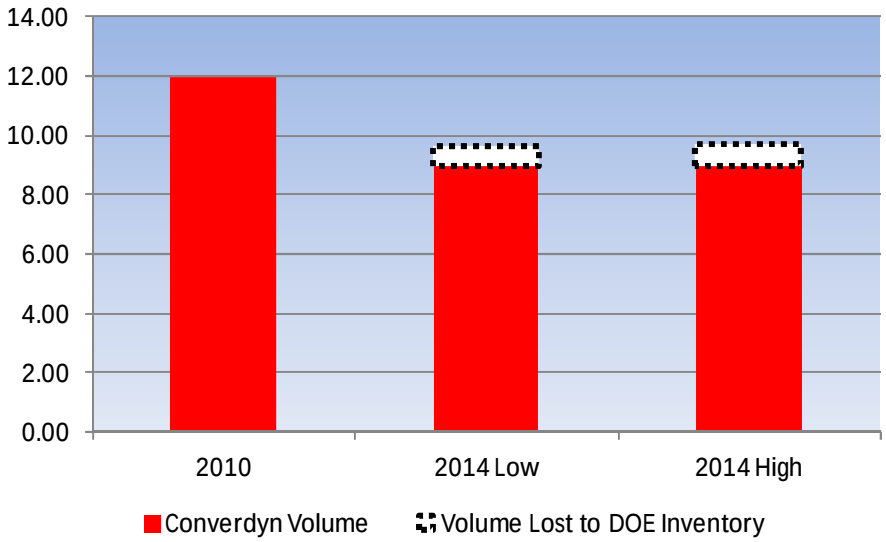


Figure 4.24 Estimated Converdyn Sales Volume in 2010 and 2014, Volume Impact of DOE Sales in 2014 Assuming Pre-Fukushima Sales Volume of 12 Million kgU as UF_6

Figure 4.24 compares Converdyn's pre-Fukushima sales volumes with its post-Fukushima sales volume, including the 0.67 to 0.72 million kgU impact to its sales volume associated with the introduction of DOE material into the market in 2014. This 0.67 to 0.72 million kgU is equal to a 6.9% (0.67 / 9.67) to 7.4% (0.72/9.72) reduction in sales volume.

Thus, assuming that Converdyn's pre-Fukushima sales volume ranged from 10 million to 12 million kgU as UF_6 and its U.S. market share ranges from 25% to 30%, the introduction of DOE inventory into the conversion market results in a volume impact of 6.9% to 8.1%. As shown in Table 4.4, the quantity of DOE inventory expected to enter the commercial market in 2014 and over the next several years is 3.02 million kgU annually. Total secondary market supplies in 2014 are expected to be approximately 16.5 million kgU. The DOE inventory represents 18% of secondary market supply in 2014, enricher underfeeding will be 29%, upgrade of tails in Russia will be 32%, plutonium and uranium recycle will be 16% and Russian HEU feed will be 4% of secondary market supply. Converdyn's sales volume is also impacted by the presence of these other secondary market supply sources in the market. However, this report only assesses the impact of DOE inventory on U.S. conversion sales volume.

Analysis of Impact on Production Cost for Conversion Services

As noted above, in the 2012 Converdyn Review, the company states that the 2 million kgU as UF_6 associated with the entry of DOE material into the conversion market would impact Converdyn's sales volumes, resulting in an increased cost per kgU of 20%. As analyzed above, ERI calculates that the volume impact to Converdyn would be 0.6 to 0.66 million

kgU if Converdyn's pre-Fukushima volume was 10 million kgU and 0.67 to 0.72 million kgU if its pre-Fukushima volume was 12 million kgU. In order to analyze the impact of this decrease in sales volume on the unit cost of production, it is necessary to make assumptions regarding the percent of production costs that are fixed and variable. Conversion facilities have high fixed costs, so ERI analyzed two scenarios assuming 80% and 100% fixed costs in order to determine the impact on production costs on a $/kgU basis.

Honeywell reports that Metropolis Works has lost more than $100 million over the past decade.[44] While Converdyn's realized price is believed to have increased over that period, unit costs have gone up as well. As shown in Table 4.6, assuming a post-Fukushima production volume of 7.5 million kgU, if DOE inventory was not introduced into the market, the volume in 2014 would be 8.1 million kgU. If this 8.1 million kgU has a production cost of $15 per kgU, and the sales price is $14/kgU (because the Metropolis Works is operating at a loss), the total sales revenue would be $113.4 million and production costs would be $121.5 million - a loss of $8.1 million. If 100% of the costs are fixed costs, then if Metropolis Works is only producing 7.5 million kgU, the fixed costs to produce this material would still be $121.5 million, but the unit production costs would increase to $16.2/kgU, or 8%.

As shown in Table 4.8, if fixed costs were 80% of the cost of production, a reduction of production volume from 8.1 to 7.5 million kgU would result in an increased cost of production of $1 per kgU as UF_6. A production volume of 8.1 million kgU would have fixed costs of $97.2 million and variable costs of $24.30 million, with total costs of $121.5 million or $15 per kgU. A production volume of 7.5 million kgU would have fixed costs of 97.2 million (the same as the 8.1 million kgU production) and variable costs of $22.5 million for total production costs of $119.70 million or $15.96 per kgU. Thus there would be a $1/kgU or 6.4% increase in production costs. The results associated with the production volumes shown in Table 4.7 for a 9 million kgU production volume yield similar results – cost increase of 7.8% for 100% fixed costs and 6.2% assuming 80% fixed costs.

[44] Pritchett, Jim, Plant Manager, Metropolis Works, Honeywell, Letter to Metropolis Works Colleagues, December 31, 2013.
http://www.honeywell-metropolisworks.com/?document=letter-to-employees-2&download=1

		Fixed Cost	Variable Cost	Total Cost of Production	Unit Cost ($/kgU)
		80%	20%		
Production Cost Components		$ 12.00	$ 3.00		$ 15.00
Production Volume		Production Costs ($ Millions)			
- without DOE sales	8.1	$ 97.20	$ 24.30	$ 121.50	$ 15.00
- with DOE sales	7.5	$ 97.20	$ 22.50	$ 119.70	$ 15.96
Increased production cost					$ 0.96

Table 4.8 Change in Production Cost for UF_6 Due to Decrease Volume Associated with Introduction of DOE Inventory into Market

The production cost increase of an estimated 6% to 8% would be in addition to the decrease in market clearing prices associated with the introduction of the DOE inventory into the market as discussed in Section 4.1.

Reduction in Workforce Associated with Volume Reduction

In an April 15, 2013 letter to employees, the plant manager at Metropolis Works noted that the total staffing of the plant at the time of its then-expected restart in Summer 2013 would be approximately 270 employees.[45] He noted that the staffing levels would be lower than in the past to reflect "current market demand and UF_6 volumes required by our customers." In July 2012, when the plant was in the process of responding to an NRC inspection and was planning for a reduction in work force, the plant manger noted that 106 employees would be needed during the plant shutdown and 228 employees would be laid off during the plant shut down.[46] Thus, prior to the 2012-2013 temporary shutdown of Metropolis Works for seismic upgrades, the work force was approximately 334. Therefore, the 270 employees that would staff the plant after it returned to production in 2013 were 80% of the pre-shutdown workforce. Based on these figures, there is some correlation of work force size to long-term production volume – thus it is unlikely that 100% of the cost of production at Metropolis Works is fixed. The cost of fluorine is variable as well.

[45] Smith, Larry, Plant Manager, Metropolis Works, Honeywell, Letter to Employees, April 15, 2013. http://www.honeywell-metropolisworks.com/?document=apr-15-2013-letter-to-employees-3&download=1

[46] Smith, Larry, Plant Manager, Metropolis Works, Honeywell, Letter to Employees, July 19, 2012. http://www.honeywell-metropolisworks.com/?document=jul-19-2012-letter-to-employees&download=1

As noted in the 2012 Converdyn Review, Converdyn experienced a 25% reduction in sales volume associated with the loss of customer demand in Germany and Japan following the Fukushima accident. If Converdyn's pre-Fukushima sales volume was between 10 and 12 million kgU annually, this would be a loss of volume of 2.5 to 3 million kgU annually. This compares to the relatively small volume reduction impact to Converdyn associated with DOE sales of 0.6 to 0.72 million kgU as shown in Tables 4.6 and 4.7 discussed above – an estimated 24% of the volume loss to Converdyn associated with the shutdown of nuclear power plants in Japan and Germany. A portion of the reduction in work force at Converdyn may be associated with the introduction of DOE inventory into the market. However other secondary supply sources such as enricher underfeeding, upgrade of tails in Russia, and Russian HEU feed are also factors in Converdyn's volume reduction.

It is also recognized that the greater the amount of secondary supply that is available to owners and operators of nuclear power plants to meet their operating requirements, particularly at the lower spot market prices, would have the potential of reducing contracting volumes under the higher priced term contracts. As was the case for all of the markets, term contracting was in fact lower during 2013. One might also expect that this would lead to the decline in term market price but it has held fairly steady, with only a slight decline during the last year.

Summary of Conversion Market Impacts

- The current over-supply in the conversion market is due Fukushima-related demand loss as well as secondary supply sources including the conversion component of HEU-derived LEU, DOE inventory, underfeeding of enrichment plants by enrichment producers, upgrade of DUF_6 tails in Russia and uranium and plutonium recycle. The planned DOE inventory release in 2014 of approximately 3 million kgU as UF_6 is equivalent to about 18% of secondary supply.

- The release of 3 million kgU as UF_6 of DOE inventory into the market in 2014 represents 5% of worldwide conversion services demand and 25% of U.S. conversion demand.

- Conversion spot market prices have declined (-38%) since the Fukushima event three years ago.

- The price impact attributed to DOE inventory entering the conversion market averages $0.9 per kgU as UF_6 over the next ten years. This is equivalent to 12% of the current spot price and 6% of the current term price.

- Sales volume impacts to Converdyn due to the introduction of DOE inventory result in a sales volume reduction of 7% to 8%, on top of Converdyn's stated 25% sales volume loss associated with Fukushima.

- The loss of sales volume is estimated to increase Converdyn's production costs by 6% to 8%.

- When Metropolis Works restarted in 2013, the workforce was 80% of the pre-shutdown workforce in early 2012. The decrease in work force was due to lower market demand.

4.2.3 Potential Impact on the Domestic Enrichment Services Industry

As discussed in Section 2, the enrichment market is currently in an oversupply situation. There are two U.S.-based enrichment suppliers – Urenco and USEC. As shown in Table 3.5, the total equivalent net million SWU that will enter the market due to transfers of DOE inventory average 0.96 million SWU per year over the period 2014 to 2023. SWU requirements in the U.S. over the period 2014 - 2023 average 15.1 million SWU per year. DOE inventory that will enter the U.S. enrichment market during this period represents 6% of total U.S. requirements, and 1.7% of world requirements, which average 54 million SWU over the period 2014 - 2023.

USEC no longer produces enriched uranium - its future sales will come from current inventory, SWU purchased from other suppliers and SWU purchased under a Transitional Supply Agreement between USEC and TENEX, as discussed in Section 2.3.3. USEC is only able to deliver limited quantities of the SWU purchased from Russia into the U.S. market – the rest must be delivered to non-U.S. customers. In its 2013 10-K report[47], USEC noted that due to its fixed commitment to purchase Russian LEU under the Transitional Supply Agreement with TENEX, any reduction in purchases by the customers below the level required for USEC to resell both its inventory and the Russian material could adversely affect revenues, cash flows and results of operations.

In its 2013 Annual Report, Urenco states that its order book as of December 31, 2013, was in excess of €17 billion, approximately €1 billion less than 2012 order. The 2013 Annual Report notes that the reduction in order book value due to deliveries made to customers was "partially offset by new agreed business, and a revaluation of US dollar elements in contracts in line with the recent euro/dollar exchange rate movements."[48]

As noted in Section 2.3.4, and shown in Figure 2.8, total world enrichment supply significantly exceeds projected requirements through 2023. Introduction of DOE inventory into the SWU market is estimated to lower prices by 4% in both the spot market and term markets. While the current market is one of oversupply due to reduced near-term demand, 95% of enrichment services and/or EUP are sold under long-term contracts. However, as discussed in Section 2.3, with the current over-supplied enrichment market, both the term and spot market prices have declined considerably. The price decline in the past three years following Fukushima has been considerable at –37% in the term market and –38% in the spot market. Most of the price decline has taken place during the two years following the May 2012 determination, with the term at -32% and the spot at -30%.

[47] USEC, Form 10-K, Annual Report For the fiscal year ended December 31, 2013.

[48] Urenco, Limited, 2013 Annual Report,

In the past, there was a benefit to USEC in 2012 and 2013 that allowed USEC to continue operation of the PGDP for an additional 12 months in order to enrich the higher assay depleted UF_6 that was transferred to ENW, discussed in Section 3.1. Also, as noted in Section 3.1, the DOE transfers of uranium materials containing equivalent enrichment services to TVA have been known to the market for many years and are long-term contracts in nature.

The enrichment industry has the ability to lessen the impact of oversupply by underfeeding its plants to make use of the excess supply. Urenco has estimated that it is now using 10% to 15% of its capacity for underfeeding or re-enriching DUF_6. The revenue generated by the subsequent sales of natural UF_6 can be significant when such a large fraction of capacity is used for underfeeding, although still less than normal commercial sales of enrichment services (if the customer demand was present).

Therefore, the potential adverse impact associated with the introduction of DOE material presently under consideration on the enrichment services industry will have a 4% impact on both the spot market and term market prices. DOE inventory that will enter the U.S. enrichment market during this period represents 6% of total U.S. requirements, and 1.7% of world requirements over the period 2014 - 2023.

Summary of Enrichment Market Impacts

- The current over-supply in the enrichment market is due primarily to Fukushima-related demand loss and the subsequent increase in inventories of EUP, with enrichers having excess capacity above enrichment requirements.

- The release of approximately 1 million SWU per year associated with the entry of DOE inventory into the market during the period 2014 to 2023 represents 1.7 - 2.5% of worldwide enrichment services demand and 6-7% of U.S. enrichment services demand over this period.

- Enrichment market prices have declined (-39% spot market, -37% term market) since the Fukushima event three years ago.

- The price impact attributed to DOE inventory entering the enrichment market averages $3.9 per SWU over the next ten years. This is equivalent to 4% of the current spot price and term price.

5. Summary of U.S. Industry Views

Following the release of the 2012 Determination and the related ERI market impact assessment, both the U.S. uranium production industry and the one U.S. converter, Converdyn, expressed concerns regarding the 2012 Determination as having "abandoned the industry consensus principles in the 2008 Plan" and of ERI's analysis of the impacts on the U.S. uranium and conversion markets. One criticism was that ERI's 2012 market impact study only focused on the price impacts associated with the entrance of DOE inventory into the commercial markets.

ERI continues to believe that the change in market price due to DOE inventory entering the market provides an important measure of the DOE material's impact on the domestic industry. As summarized in Section 4, ERI undertook analysis to address additional metrics to assess the impact of DOE material on the uranium market such as employment, production, volumes of inventory relative to market volumes, market capitalization, realized prices and productions costs in the uranium market. The DOE inventory's role relative to other market factors is examined as well. In the conversion market, in addition to market price impacts associated with DOE inventory additional metrics were examined including impacts on U.S. converter sales volume, production costs, and the reduction in workforce associated with reduced sales volumes.

ERI also spoke with representatives from U.S. uranium producers and Converdyn in order to listen to their concerns regarding what they see as important factors associated with the impact of the DOE inventories on the uranium and conversion markets and on their companies. ERI also asked a representative of the sole U.S. producer of enriched uranium for feedback. Concerns expressed by the U.S. industry to ERI directly or through industry presentations are summarized below. ERI believes that its analysis has captured many of the additional metrics raised by U.S. producers and Converdyn in the analysis summarized in Section 4. The views expressed below are a summary of the U.S. uranium producers and Converdyn comments to ERI. The inclusion of these views represents neither an endorsement nor a critique by ERI.

5.1 U.S. Uranium Industry

ERI has spoken with uranium producers representing more than 70% of facilities in operation and over 90% of 2013 uranium production in the U.S. as well as a producer that is in the process of starting production at a new facility. In its discussions with representatives of the U.S. uranium industry, the following key views emerged:

- DOE inventory releases are adversely impacting the market. Because there are no production costs or minimum values assigned to the DOE inventory when it enters the market, it has no underlying cost basis. Therefore, in a market with considerable oversupply and only limited discretionary demand, other suppliers who need to sell material may try to "beat" the DOE material into the market, offering

their supply at lower and lower prices rather than competing directly with the DOE inventory. This dynamic leads to ever lower prices and amplifies the impact of the DOE material on market price.

- According to U.S. uranium producers, adverse impacts[49] have and continue to occur to the U.S. industry and include:
    - Producers have cut production targets, employment and investment in response to current market conditions as well as future market prices.
    - The number of drill rigs operating in the U.S. has fallen dramatically - this is a sign of future production cut backs.
    - Employment is down as much as 50% from 2012. Employment is a major issue.
    - If the market does not improve, there will be further impacts and the shutdown of additional production.
    - Lower market capitalization due to lower spot market prices decreases uranium producers' ability to attract money for development, ultimately impacting production and employment.
    - In the current thinly traded market, producers are unable to realize the published long-term price indicator in supply contracts because buyers want to lock in current spot market prices. At a $34 per pound market price, it is difficult to demonstrate shareholder value and future operations are put at risk as a result.
    - Current spot market prices are well below the average production cost for the U.S. uranium industry. The industry cannot survive if these conditions persist.

- According to U.S. uranium producers, predictability is critical. The decision by DOE in its July 2013 Plan to officially abandon the industry consensus principles in the DOE 2008 Plan (which was a guideline that DOE inventory transfers, limited to 10% of U.S. uranium requirements, would not result in adverse impact) was interpreted by the U.S. industry and the investment community as an indication that DOE will not act in a predictable way regarding future inventory releases and that future inventory releases are subject to increase above planned values. Some producers directly attribute a $5/lb decline in spot price to the release of the July 2013 Plan.

- While the US uranium industry has reacted to current market conditions by cutting back production (and jobs), DOE has not changed its inventory releases in response to the current weak market. The perception that DOE has taken no action to mitigate the impacts of the release of DOE inventory in an oversupplied market with

[49] It is recognized that the current state of the industry is due to more than just DOE inventory releases. The impact of Fukushima is generally acknowledged as a dominating market factor.

a uranium supply industry under stress represents an adverse impact in the view of U.S. producers. If DOE were to reduce its sales in recognition of the current depressed market, producers believe this would send a strong, positive signal to the market. Lower releases would have a positive impact on market psychology.

- The U.S. industry needs sustained (spot) market prices of $50 to $60 per pound or more.

- DOE is the only entity in the uranium market that has a statutory obligation to not have an adverse material impact on the U.S. uranium, conversion and enrichment industries. DOE should control and limit the impact of its inventory releases by returning to the industry consensus principles that were part of the DOE 2008 Plan. U.S. producers expressed an opinion that the 10% guideline represents a compromise the industry can live with.

5.2 U.S. Conversion Industry

ERI has spoken with the sole U.S. converter, Converdyn, regarding its views on impacts associated with DOE inventory releases in addition to reviewing Converdyn's public comments following the 2012 Determination. The following summarizes key views expressed by past and current Converdyn representatives regarding the impact of DOE inventory releases on the U.S. conversion industry:

- One of the important impacts on U.S. conversion services is the loss of volume associated with the entrance of DOE inventory into the conversion market. Converdyn experienced a 25% loss of volume in sales following the March 2011 Fukushima accident. Additional DOE inventory entering the market results in further sales volume loss.

- The spot market for conversion services is more thinly traded than that for uranium.

- Converdyn has seen a change in buyer behavior due to the large difference between spot and term prices – in which buyers are looking to the spot market, rather than signing long-term contracts. This further erodes Converdyn's contracted sales volume.

- Honeywell estimates that it has lost $100 million over the last decade associated with operation of the Metropolis Works conversion facility.

- Metropolis Works has high fixed production costs. Therefore, any additional loss of sales volume associated with the introduction of DOE inventory into the market results in an even higher cost per kgU of UF_6 produced.

- Converdyn believes DOE inventory releases are adversely impacting the conversion market. Current spot market prices are the result of an oversupplied market that includes DOE inventory and are well below Metropolis Works' production costs.

6. Summary of Market Impact

This section summarizes the market impacts associated with the entry of DOE inventories into the domestic uranium, conversion and enrichment markets. This includes an evaluation of the price impact associated with the entry of DOE material in the commercial markets and the subsequent displacement of commercial supply. Other metrics were also evaluated for the domestic industries including: employment, production, volumes of inventory relative to market volumes, market capitalization, realized prices and production costs for the uranium production industry; and U.S. converter sales volumes, production costs and workforce reductions; and impact on volumes of enrichment services.

6.1 DOE Inventory Entering the Market, 2014 to 2033

During the period 2014 to 2033, the total DOE inventory entering the market equals more than 49,000 MTU as UF_6, which is equivalent to 129 million pounds of U_3O_8. A total of 9.7 million SWU will enter the market during the period 2014 to 2023. No additional equivalent SWU are identified to enter the market after 2023. The DOE inventory transfers that are expected to displace global commercial supply in the markets over the next ten years (2014 through 2023) average nearly 2,850 MTU as UF_6, equivalent to 7.4 million pounds U_3O_8 per year. This is equivalent to approximately 15% of annual U.S. uranium requirements and 15% of U.S. conversion requirements. During the subsequent ten years (2024-2033) the global commercial uranium supply displaced by DOE inventory declines to an average of 5.5 million pounds per year, or nearly 12% of U.S. uranium requirements.

6.2 Current Market Conditions

It is clear that all of the markets - uranium concentrates, conversion services and enrichment services - are in states of considerable oversupply, with mainly discretionary near-term demand for nuclear fuel and a decline of long-term contracting over the past year. The long-term prospects for nuclear power and nuclear fuel supply are generally viewed as positive, with a steady average annual nuclear capacity growth rate of 1.8% through 2035, with related growth in nuclear fuel requirements. Growth in the U.S. remains relatively flat through 2035, with the strongest growth expected to take place in China, India, Korea, and Russia. However, in the near term, the amount of time it will take to recover from the Fukushima-driven state of the current markets is unclear. It is clear that excess supply will need to be reduced before any recovery in market price can take place. In the meantime, the domestic industries are feeling the effects of the oversupplied markets and are taking actions, such as production and staffing cutbacks, in order to try to weather the downturn. The impacts are most acute in the uranium and conversion industries.

6.3 Nuclear Fuel Market Impacts

Market conditions have deteriorated considerably since the last market impact study was completed in April 2012. While the 2012 market impact study did foresee oversupply due

to Fukushima and other factors, the timing for restart of Japanese reactors and the recovery of worldwide nuclear power development has been slower than anticipated and the subsequent reduction in nuclear fuel demand has been worse than anticipated at that time. Primary supply has continued to increase as well, further suppressing the market. As a result, market prices have fallen considerably over the last two years. While the impacts on price found in the current analysis are similar to the impacts found two years ago in absolute terms, they are now more significant when evaluated against current market prices.

The overall status and changes in the nuclear fuel markets have been characterized in this market impact study; however, it is more difficult to attribute the relative "responsibility" of each of the many factors which influence the market price indicators. While the DOE inventory releases clearly play a role, they must be judged in context of all market factors including reduced demand following the accident at Fukushima Daiichi as analyzed in Section 4 and summarized below. This market impact study has estimated impacts from the transfer of DOE inventory and its subsequent displacement of commercial supply in the markets, which represent a share or fraction of all the changes which have taken place over the past two to three years.

6.3.1 Price Impact

The results of ERI's market clearing price analysis indicate that the price impact attributed to DOE inventory entering the uranium market averages $3 per pound over the period 2014-2023. This is equivalent to 8% of the current spot price and 6% of the current term price. The price impact attributed to DOE inventory entering the conversion market averages $1 per kgU as UF_6 over the next ten years. This is equivalent to 12% of the current spot price and 6% of the current term price. The price impact attributed to DOE inventory entering the enrichment market averages $4 per SWU over the next ten years. This is equivalent to 4% of the current spot price and term price.

ERI has also developed a multivariable correlation between the monthly spot market prices for uranium concentrates published by TradeTech and the monthly spot market values of supply and demand, which are also published by TradeTech. This correlation was then used to simulate the 2009 through 2021 spot market price for uranium concentrates with and without the DOE inventory entering the spot market. The results of applying this correlation are projections of a potential spot market price decrease of $2.8 per pound U_3O_8 over the next three years (2014-2016) rising to an average decrease of $5.5 between 2017 and 2021 as spot market prices recover. This represents an estimated impact on spot market price of 7% to 9% from DOE inventory entering the uranium market.

As a point of comparison, it is noted that uranium price indicators have declined by 50% for the spot market and 35% for the term market in the three years following the Fukushima accident.

6.3.2 Other Market Factors

In addition to quantifying the impact of DOE inventory on the price of uranium, conversion and enrichment, this market impact study addresses additional metrics such as employment, production, volumes of inventory relative to market volumes, market capitalization, realized prices and productions costs in the uranium market. The DOE inventory's role relative to other market factors is examined as well. Impacts, in addition to market price impacts associated with DOE inventory entering the conversion market, include impacts on U.S. converter sales volume, production costs, and the reduction in workforce associated with reduced sales volumes.

Uranium Market Impacts

- **Employment**: A price-employment correlation has been used to estimate the impact of the DOE inventory releases on U.S. uranium industry employment. The estimate of the impact of DOE material on market price in 2013 is $3.4/lb, resulting in an estimated employment loss of 50 person-years as a result of the DOE inventory entering the market. This corresponds to a reduction in uranium industry employment of 4.4% in 2013. Looking forward, the impact of DOE uranium inventory entering the commercial market is expected to average nearly $3/lb over the next ten years (2014-2023). This results in an estimated long-term employment loss of 44 person years, meaning that future employment is reduced by approximately 4% on average as a result of the DOE inventory releases.

- **Production**: While U.S. uranium industry production has risen since 2003 and continued to rise after the start of the DOE uranium inventory barters in December 2009 as well as during the market decline in 2013, there has been an impact to the actual and planned production of some U.S. operations. There have been announced cutbacks in existing U.S. uranium production in 2012 and 2013. In 2013, the reduction in production from these cutbacks was limited but is expected to be about 1.0 million pounds in 2014. Total U.S. production is expected to increase in 2014 as new production more than offsets the cutbacks.

- **DOE Inventory Relative to Total Market Supply:** The DOE inventory's share of total uranium market supply has grown from about 1% in 2008 to 4% currently. Comparison of DOE inventories relative to total secondary supply for uranium shows that DOE inventory has grown from 4% of secondary supply in 2008 to 17% in 2013. Secondary supply declines in 2014 with the end of the HEU Agreement, resulting in an increase in the DOE inventory's share of total secondary supply to approximately 19%. Comparison of DOE inventory entering the spot market against total spot market volume shows that the DOE material sold on the spot market has increased from 1% in 2009 to about 5% in 2010-2012 and 9% in 2013. The DOE material sold on the spot market is expected to remain at levels similar to 2013 for the next ten years.

- **DOE Inventory Relative to Other Market Factors**: Some of the primary market factors that have impacted the uranium supply-demand balance include: loss of uranium demand in Japan and Germany following the Fukushima accident in 2011; increases in uranium demand worldwide (outside of Japan and Germany); the end of the U.S. Russian HEU Agreement in 2013; increased uranium production in Kazakhstan; changes in other secondary supply sources included enricher underfeeding and upgrade of DUF_6 tails in Russia. Comparing market factors that contributed to 2013 supply excess relative to 2008 shows that the increased supply from the DOE inventory entering the market was responsible for about 10% of the total of all market factors increasing excess supply in 2013 and a projected 8% for 2014. If DOE inventory entering the commercial markets had remained at 2008 levels then the net supply excess for 2013 and 2014 would decline by 15% to 20%, but the uranium market would still be considerably over-supplied.

- **Market capitalization**: Market capitalization is an important metric for the smaller, publicly traded mining companies in the U.S. because it is representative of the ability of these companies to raise funds needed to move projects through the licensing process, which can take many years, as well as initial project development in some cases. Review of market capitalization for U.S. uranium producers shows that it is sensitive to changes in the spot market price, particularly for smaller mining companies. For example, during 2010, spot price increased from $40 per pound up to $70 per pound, an increase of 75%. The market capitalization of the smaller U.S. miners increased 150% to 600% in response. Following the Fukushima accident in March 2011, market capitalization declined rapidly. While the impact of large changes in the spot market price is obvious, the effect on market capitalization from the smaller price changes attributed to DOE inventory entering the market is not as clear. It is of interest to note that the market capitalizations have been increasing during the last six months even though market prices have declined.

- **Realized Prices**: The EIA publishes average delivered price in the U.S., which have increased steadily over the past ten years, before leveling off in 2012. While EIA has not yet published data for year-end 2013, a small decline is expected by ERI. The EIA average delivered price in the U.S. is representative of realized prices for the uranium industry on a global basis. Realized prices for the U.S. uranium supply industry varies from one company to another. ERI reviewed realized prices as reported in uranium producers' public filings, representing 95% of U.S. production in 2013. Comparing realized prices to the spot market price during the period 2011 to first quarter 2014 shows that some mining companies' realized prices are spot-market based while others have hedged their exposure to the spot market by locking in prices using a base price escalated approach for a portion of their portfolio. Less than 30% of the production came from companies that were effectively unhedged (no long-term contracts with higher fixed prices).

- **Production Costs**: The EIA reports total industry expenditures for U.S. uranium production, including facility expense, in its annual Domestic Uranium Production Report. The total for 2012 was $187 million, or an average of $45 per pound when

spread across 2012 uranium production of 4.15 million pounds in 2012. These costs have been rising since 2010. If DOE inventory were removed from the market, effectively adding back the $2 to $3 per pound price impact attributed to the DOE inventory material, it is unlikely that current market prices would rise enough to cause current production centers to ramp wellfield development and production activities back up. The resulting price level of $36 to $37 per pound would remain less than $40 and may still not be sufficient for some ISL producers to restart wellfield development activities, and likely would not have prevented the decisions to cut back production. If market prices remain at the current depressed levels for several years, which seems to be the consensus view of many in the industry, then more U.S. production will be impacted and may be put on standby, as existing longer term contracts at higher prices are completed and can only be replaced by new, lower-priced contracts.

Conversion Market Impacts:

- **Impact on Conversion Services Sales Volume:** The introduction of DOE inventory into the conversion market results in a sales volume impact of 0.6 to 0.7 million kgU, which is a 7% to 8% reduction in sales volume. This is on top of Converdyn's stated 25% sales volume loss associated with Fukushima.

- **Comparison of DOE Inventory with Other Secondary Supply Volumes**: Total secondary market supplies in 2014 are expected to be approximately 16.5 million kgU. The DOE inventory represents 18% of secondary market supply in 2014, enricher underfeeding will be 29%, upgrade of tails in Russia will be 32%, plutonium and uranium recycle will be 16% and Russian HEU feed will be 4% of secondary market supply as discussed in Section 4.2.2. Converdyn's sales volume is also impacted by the presence of these other secondary market supply sources in the market.

- **Impact on Conversion Services Production Cost**: As noted above, DOE inventory is projected to have a 7% to 8% impact on Converdyn sales volume in 2014. The production of UF_6 has high fixed costs. The loss of sales volume associated with DOE the entry of DOE material in the conversion market, assuming that the fixed portion of production costs range from 80% to 100%, results in a production cost increase of 6% to 8%.

- **Workforce Reduction Associated with Volume Reduction**: Prior to the 2012-2013 temporary shutdown of Metropolis Works for seismic upgrades, the work force was approximately 334. When the plant returned to production in July 2013, the workforce was 270 employees[50], 80% of the pre-shutdown workforce. According to plant managers, the decrease in work force was due to lower market demand, a

[50] Smith, Larry, Plant Manager, Metropolis Works, Honeywell, Letter to Employees, April 15, 2013. http://www.honeywell-metropolisworks.com/?document=apr-15-2013-letter-to-employees-3&download=1

portion of which was the result of the impact of DOE inventory on Converdyn sales volume as summarized above.

Enrichment Market Impacts

- **Enrichment Market Volume Impact**: The current over-supply in the enrichment market is due primarily to Fukushima-related demand loss and the subsequent increase in inventories of EUP, with enrichers having excess capacity above enrichment requirements. The release of approximately 1 million SWU per year associated with the entry of DOE inventory into the market during the period 2014 to 2023 represents 1.7 - 2.5% of worldwide enrichment services demand and 6-7% of U.S. enrichment services demand over this period.

6.3.3 Predictability

As stated by ERI in its 2012 market impact study, even if the potential impact of any individual transfer by DOE is not in itself significant, the nuclear fuel markets recognize that DOE controls a very large amount of material. The predictability of DOE's transfer of that material into the commercial markets over time is very important to the orderly functioning of these markets. In this regard, it is critical for long-term planning and investment decisions by the domestic industry that there can be confidence that DOE will adhere to what it presents as being established guidelines and plans. In the 2013 DOE Plan, DOE stated that it "determined that it can meet its statutory and policy objectives in regard to DOE uranium sales or transfers without an established guideline." The 2013 Plan stated that the previously established guideline limiting DOE transfers to 10% of U.S. annual requirements, which was established in DOE's 2008 Plan, would no longer be used. Based on feedback that ERI received from representatives of the U.S. uranium and conversion industries, the decision by DOE to no longer have an established guideline that would limit DOE inventory transfers to 10% was interpreted by the U.S. industry and investment community as an indication that DOE will not act in a predictable manner regarding future inventory releases.

The ERI 2012 market impact study also stated that unless DOE can demonstrate to the domestic fuel supply industry that its transfer of material during any year(s) will remain predictable and that DOE will not make future transfers without any regard for the "*maintenance of a strong domestic nuclear industry*", then DOE actions may, in fact, have an adverse material impact on the domestic industry. It is important to note that the inventory transfer levels that DOE specified for use in this 2014 market impact analysis are consistent with the May 2012 Determination through the year 2020. While DOE has taken steps towards improved[51] predictability since the release of the 2013 Plan, it is not clear that this standard has been met – certainly not in the view of domestic industry.

[51] The most recent RFO for additional DUF_6 specifically states that resulting natural UF_6 cannot enter the markets prior to 2019 and limits the quantities to 2,000 MTU per year. DOE also plans to lower the quantity

6.4 Final Notes

As previously noted, it is clear that there have been production, employment and financial impacts on the domestic industry due to a variety of market factors culminating in the current oversupplied markets. Based on the analysis contained in this study, it is not clear that a reduction in DOE inventory releases would cause the overall market conditions to change enough to make a significant difference in the health and status of the domestic industries. However, based on feedback that ERI received from representatives of the U.S. the uranium and conversion industries, they clearly feel that a reduction in the amount of DOE inventory entering the markets would make a difference, in part by sending a strong signal to the markets that DOE recognizes the current weak state of the nuclear fuel markets, in which there is considerable oversupply, near-term demand is mostly discretionary, and long-term contracting has declined considerably over the past year, and that DOE is responding to these market conditions.

In the context of a much stronger price environment, the market impact study conducted by ERI two years ago judged, at that time, that the impacts of the DOE inventory releases were small enough so as to not constitute a material adverse impact. DOE and ERI sought to clarify ERI's role in the development of this market impact study. ERI's role is to analyze the impacts associated with the release of DOE inventories into the commercial markets for the period 2014 to 2033. In accordance with the USEC Privatization Act, any determination of "adverse material impact" is made by the Secretary of Energy. As such, this market impact assessment does not make any conclusion regarding whether or not the release of DOE inventories into the commercial markets will result in an adverse material impact.

of EM barters to compensate for possible increases in NNSA barters due to lower market prices.

GLOSSARY

ACP – USEC's planned Advanced Centrifuge Plant.

centrifuge – A device that can spin at extremely high speeds and separate materials of different densities. For uranium, centrifuges are able to separate the uranium-235 isotopes from the uranium-238 isotopes based on their difference in atomic weight.

conversion – In the context of nuclear fuel, the process whereby natural uranium in the form of an oxide is converted to uranium hexafluoride.

depleted uranium (DU or DUF_6) – Uranium whose content of the fissile isotope uranium-235 is less than the 0.711 percent (by weight) found in natural uranium, so that it contains more uranium-238 than found in natural uranium.

down blending – The term used to describe the process whereby highly enriched uranium is mixed with depleted, natural, or low enriched uranium to create low enriched uranium.

enriched uranium – Uranium whose content of the fissile isotope uranium-235 is greater than the 0.711 percent (by weight) found in natural uranium. (See uranium, natural uranium, and highly enriched uranium.)

enrichment – In the context of nuclear fuel, the separation of the uranium-235 isotope from the more common uranium-238 isotope to create enriched uranium.

equivalent – In the context of uranium concentrates equivalent, conversion services equivalent, enrichment services equivalent, this refers to the equivalent amount of each of these materials and services that is included in the LEU that is derived from the blended down HEU. While the LEU is not physically subdivided into these components, from a commercial perspective the components can be transferred individually.

fissile material – Any material fissionable by thermal (slow) neutrons. The three primary fissile materials are uranium-233, uranium-235, and plutonium-239.

gaseous diffusion – A uranium enrichment process where uranium hexafluoride in gaseous form is forced through a series of semi-porous membranes to increase the concentration of uranium-235 isotopes.

highly enriched uranium or HEU – Uranium whose content of the fissile isotope uranium-235 has been increased through enrichment to 20 percent or more (by weight). (See natural uranium, enriched uranium, and depleted uranium.)

kgU – Kilograms of uranium.

long-term or term price – In the context of this report, refers to the price paid for nuclear fuel materials and services that will be delivered more than one year after the contract is signed.

low-enriched uranium or LEU – Uranium whose content of the fissile isotope uranium-235 has been increased through enrichment to more than 0.7 percent but less than 20 percent by weight. Most nuclear power reactor fuel contains low-enriched uranium containing 3 to 5 percent uranium-235.

MT and MTU – Metric tons and metric tons of uranium.

natural uranium or NU– The material provided to a uranium enricher for producing enriched uranium and uranium tails.

reactor core – The fuel assemblies, fuel and target rods, control rods, blanket assemblies, and coolant/moderator of a nuclear power plant. Energy is produced in this part of the nuclear power plant.

separative work units or SWU – The unit of measurement for the effort needed to enrich uranium.

spot market price or spot price – In the context of this report, refers to the price paid for nuclear fuel materials and services that will be delivered soon (e.g., usually within 12 months) after the contract is signed.

tails – Refers to depleted uranium produced during the uranium enrichment process.

term or term market price – See **long-term price**.

uranium concentrates or U_3O_8 – The form of uranium that is the end product of the uranium milling process, which follows mining of the uranium ore. This compound can be converted through a uranium conversion process into uranium hexafluoride.

uranium hexafluoride or UF_6 – The form of uranium that is the end product of the uranium conversion process. This compound can be easily transformed into a gaseous state at relatively low temperatures to allow the uranium to feed through a uranium enrichment process, either gaseous diffusion or gas centrifuge.