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ERI-2142.16-1301

Quantification of the Potential Impact on Commercial Markets of Introduction of the Enrichment Services Component of DOE Low Enriched Uranium Inventory During Calendar Year 2013

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NOTICE

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On March 11, 2008 the Secretary of the U.S. Department of Energy (DOE) issued a policy statement on management of the DOE's excess uranium inventory. It stated that

> *"To the extent practicable, the Department will manage its uranium inventories in a manner that is consistent with and supportive of the maintenance of a strong domestic nuclear industry. Consistent with this principle, the Department believes that, as a general matter, the introduction into the domestic market of uranium from Departmental inventories in amounts that do not exceed ten percent of the total annual fuel requirements of all licensed nuclear power plants should not have an adverse material impact on the domestic uranium industry."*

In support of the Secretary's policy statement, DOE published its "Excess Uranium Inventory Management Plan" (DOE 2008 Plan) on December 16, 2008. Various segments of the U.S. nuclear industry (e.g., owners and operators of nuclear power plants as well as nuclear fuel suppliers and their trade associations) stated their support for the DOE 2008 Plan.

This report presents the results of a business analysis performed by Energy Resources International, Inc. (ERI) of the potential impact on the commercial enrichment market of the transfer of the enrichment services component (Separative Work Units or SWU) contained in DOE low enriched uranium (LEU) inventory during 2013. Under this transaction, 299,000 kg SWU would be introduced into the commercial market, but no transfer of natural uranium to the commercial market would take place. From a market perspective, the proposed transaction reverses DOE's March 2012 purchase of enrichment services from USEC. Therefore, the 2012 to 2013 time frame the net transfer of enrichment services to the commercial market from the two transactions will be zero.

The transfer of an additional 0.3 million SWU in 2013, when assessed in conjunction with other possible transfers of equivalent new enrichment services into the market by DOE, results in a total transfer to the commercial market that remains well below 10% of U.S. enrichment requirements in 2013. The total to be transferred to the commercial markets from HEU down blend remains consistent with the representative amount for 2013 originally projected in the DOE 2008 Plan, as does the net total from all DOE transfers of enrichment services.

The potential impact on term market prices of enrichment services for all DOE transfers is an estimated $3.70 per SWU, equivalent to 2.7% of the current term price. If credit is taken for the enrichment services required to re-enrich DUF_6 to natural levels during 2013, then the potential impact on term market prices is an estimated $1.40 per SWU, equivalent to 1.0% of the current term price.

ERI does not believe that either (i) the potential price effect associated with the transfer by DOE of an additional 0.3 million SWU to USEC during 2013; or (ii) the quantities of domestic enrichment services, if any, that might be displaced due to the proposed DOE transfers are of a magnitude that they would constitute a material adverse impact on the domestic enrichment industry, taking into account the sales of uranium under the U.S.-Russia Highly Enriched Uranium Agreement (HEU Agreement) and the Suspension Agreement.

1. INTRODUCTION

On March 11, 2008 the Secretary of the U.S. Department of Energy (DOE) issued a policy statement on management of the DOE's excess uranium inventory. It stated that

> *"To the extent practicable, the Department will manage its uranium inventories in a manner that is consistent with and supportive of the maintenance of a strong domestic nuclear industry. Consistent with this principle, the Department believes that, as a general matter, the introduction into the domestic market of uranium from Departmental inventories in amounts that do not exceed ten percent of the total annual fuel requirements of all licensed nuclear power plants should not have an adverse material impact on the domestic uranium industry."*

This report presents the results of a business analysis performed by Energy Resources International, Inc. (ERI) of the potential impact on the commercial enrichment market of the transfer of the enrichment services component (Separative Work Units or SWU) contained in DOE low enriched uranium (LEU) inventory during 2013.

The transaction analyzed by ERI herein involves the transfer of the SWU component contained in DOE enriched uranium product (EUP) to USEC for which DOE will receive UF_6 and the value of the SWU contained in the EUP in return. Under this transaction, DOE will provide 47,646 kg EUP to USEC and will receive in return from USEC 408,834 kg UF_6 at 0.711 weight percent (w/o) Uranium-235 and the value of the 299,000 kg SWU contained in the EUP. The material that would then be introduced into the commercial market is the 299,000 kg SWU contained in the EUP. No transfer of uranium to the commercial market is contemplated as part of this transaction. Therefore, the market impact assessed in this analysis is that to the enrichment services market only. There would be no market impact to the uranium or conversion markets associated with this transaction.

In March 2012, DOE and USEC signed a LEU sales agreement in which DOE purchased the same quantity of SWU, in the form of LEU, from USEC via a typical toll enrichment services transaction. In that 2012 transaction, $44 million of cash was returned to USEC that had been cash collateral supporting financial assurances for the disposition of a quantity of depleted uranium that was transferred to DOE in exchange for DOE acquiring LEU from USEC. DOE provided the natural UF_6 feed to USEC for enrichment.[1] Over the 2012 to 2013 time frame the net transfer of enrichment services to the commercial market from the March 2012 and proposed 2013 transaction will be zero. USEC is expected to deliver the SWU transferred from DOE in 2013 under an existing term contract, although a new spot market sale is also possible.

[1] USEC Updated Outlook for 2012 Financial Metrics, USEC Press Release, June 27, 2012.

This analysis also takes into account all other sales or transfers of SWU by DOE into the market during 2013. These other sales or transfers of SWU were previously analyzed by ERI in a report issued in April 2012 (2012 Market Impact Assessment).[2] These include the SWU component associated with transfer of LEU by the DOE National Nuclear Security Administration (NNSA) into the commercial enrichment market, which results from the down blending of highly enriched uranium (HEU) under several programs as well as the enrichment of depleted UF_6 (DUF_6) that has been transferred to Energy Northwest for enrichment by USEC, Inc.

In support of the Secretary's Policy Statement, DOE published its "Excess Uranium Inventory Management Plan" (DOE 2008 Plan) on December 16, 2008. According to the DOE 2008 Plan,

> *"The objectives of the Plan are to seek to: (1) enhance the value and usefulness of DOE's uranium by converting a portion of it into a low enriched uranium (LEU) inventory; (2) reduce DOE programmatic costs by decreasing uranium inventories; (3) meet key nonproliferation objectives; and (4) dispose of unmarketable material to facilitate the cleanup of DOE's gaseous diffusion plants (GDPs). DOE also anticipates that it will undertake to optimize the use and disposition of its excess uranium assets in a manner that also minimizes any material adverse impacts on the domestic uranium mining, conversion and enrichment industries.*
>
> *"The Plan addresses the disposition of DOE's excess uranium identified in this Plan through potential sales or transfers of uranium based on a combined annual quantity of no more than ten percent of the annual U.S. nuclear fuel requirements. The Department may exceed the ten percent in any given year for certain special purposes, such as initial core loads for new reactors. Uranium disposition decisions will be undertaken in a manner that is consistent with DOE's mission needs and the principles set forth in the Policy Statement. DOE sales or transfers would be conducted consistent with applicable legal requirements and will result in the U.S. Government's receipt of reasonable value."*

It should be noted that the various segments of the U.S. nuclear industry (e.g., owners and operators of nuclear power plants as well as nuclear fuel suppliers and their trade associations) stated their support for the DOE 2008 Plan[3,4] As DOE's plans for the disposition of the natural uranium portion of its inventory have evolved, natural uranium

[2] Energy Resources International, Inc., 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.

[3] Uranium Producers of America, News Release, "UPA Applauds the DOE Excess Uranium Inventory Management Plan", December 22, 2008.

[4] Nuclear Energy Institute, "Industry Position on Disposition of DOE's Nuclear Fuel Inventory vs. DOE Management Plan", December 16, 2008.

producers and the nuclear industry lobbying organization have expressed concern regarding increases in the amount of uranium transferred above any guidelines previously presented in the DOE 2008 Plan[5,6,7].

Section 2 provides background information on the enrichment services market, the only nuclear fuel market sector that would potentially be affected by the transfer of these enrichments services by DOE. Both spot and term price indicators for enrichment services market, together with the observed volatility or change in these prices, are also presented. This information serves as a basis for understanding the relative importance of the quantity of DOE material involved in this transaction, compared to U.S. requirements for enrichment services in 2013, as well as in comparison to the transactions previously analyzed in the 2012 Market Impact Assessment. It also provides additional perspective with regard to the potential impact of such transfers relative to published market prices.

Section 3 identifies and discusses the quantities of equivalent DOE enrichment services associated with the this transaction and the potential transfers previously analyzed in the 2012 Market Impact Assessment, including disposition of the enriched DUF_6 and down blended HEU.

Section 4 presents quantitative and qualitative estimates of the potential impact of the above described transfer of DOE equivalent enrichment services in 2013 on the domestic enrichment industry, with particular attention to the potential effect of these transfers on market clearing prices[8]. To provide perspective, comparisons are provided regarding the size of these potential price effects relative to changes in published spot and term market prices that have occurred in the past.

[5] Uranium Producers of America, Letter from William P. Goranson, President of UPA, to Honorable Steven Chu, Secretary of the U.S. Department of Energy, August 4, 2009.
[6] Uranium Producers of America, Letter from William P. Goranson, President of UPA, to Honorable Steven Chu, Secretary of the U.S. Department of Energy, October 13, 2009.
[7] Fertel, M.S., Nuclear Energy Institute, Letter to Dr. Steven Chu, Secretary of Energy, U.S. Department of Energy, September 2, 2010.
[8] In any particular year, the market clearing price (or equilibrium price) for enrichment services is based on the cost of production of the last increment of enrichment services that must be supplied by the market in order to provide the total quantity of enrichment services that is demanded by the market during that year.

2. BACKGROUND ON ENRICHMENT SERVICES MARKET

In order to better understand the potential impact that DOE transfers could have on the commercial markets for nuclear fuel materials and services it is useful to have some background regarding the current status on the enrichment services market and the expectations that market participants have regarding the future. At a minimum, this allows one to better appreciate (i) the relative size of the DOE transfers in the context of the enrichment services market, (ii) the manner in which published market prices have behaved in the past, and (iii) how the potential price impacts of the DOE transfers relate in size to historical volatility in enrichment services market prices.

The ERI nuclear power 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.[9] These forecasts also 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.

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 Enrichment Services Requirements

While a high level of uncertainty still remains regarding a number of countries following the events at the Fukushima Daiichi Nuclear Power Plant in Japan, the long-term impact on the future use of nuclear power has become more negative over the past year. The near-term reduction in demand has become more pronounced, as all but two Japanese reactors remain in outages that now appear likely to extend for at least another year. Lower projections of installed nuclear generation capacity of course lead to lower requirements for nuclear fuel.

ERI's Reference Nuclear Power Growth requirements forecast indicates world requirements for enrichment services will increase from the present level of about 41 million SWU per year in 2012 and 42 million SWU per year in 2013 to 56 million SWU in 2020, and 68 million in 2030. This is a 66% increase over a period of almost 20 years.

[9] Energy Resources International, Inc., 2012 Nuclear Fuel Cycle Supply and Price Report, Update, ERI-2006-1202, December 2012.

Figure 2.1 provides a summary of U.S. requirements for enrichment services over the period 2012 through 2035 that is based upon ERI's current Reference Nuclear Power Growth forecasts. The saw tooth nature of these annual requirements is a reflection of the preponderance of U.S. nuclear power plants that operate on 18 or 24 month refueling cycles. In the near term, U.S. requirements have been largely unaffected by the Fukushima-related issues affecting some countries in other parts of the world. In the long term, the prospect for growth in U.S. requirements has been affected by low natural gas prices and lower demand for electric power.

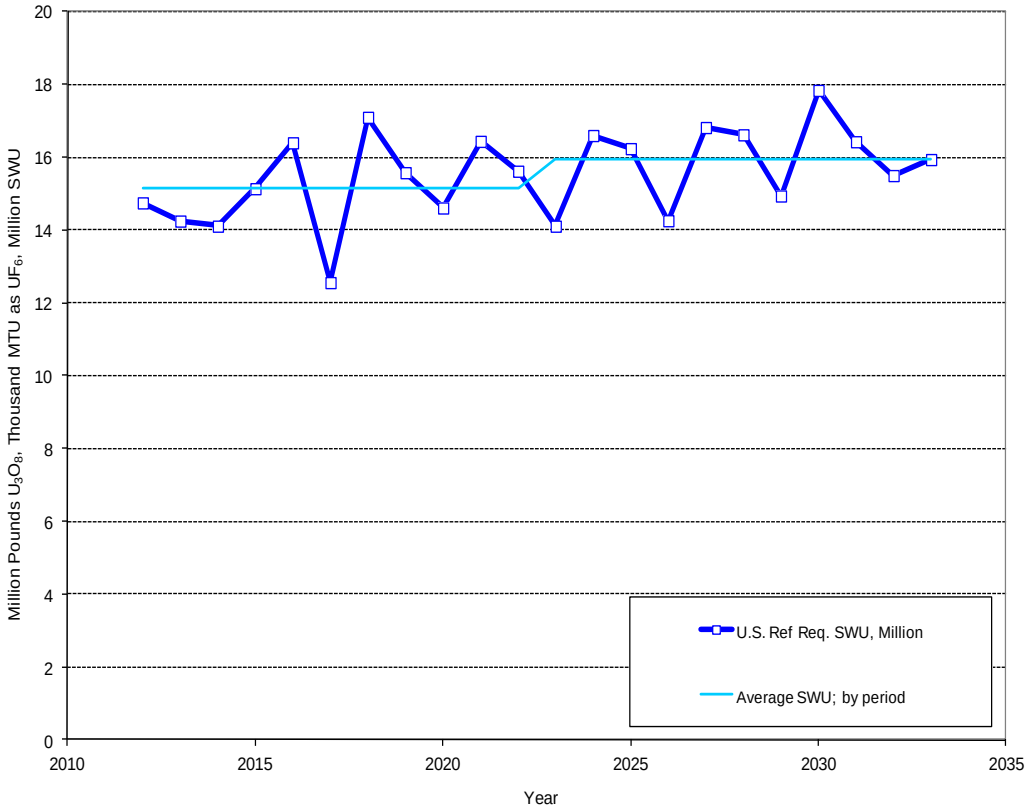

Figure 2.1 U.S. Requirements for Enrichment Services

U.S. requirements are forecast to increase from the present level of 14.8 million SWU per year in 2012 and 14.3 million SWU per year in 2013 to 17.8 million SWU per year in 2030, which is a 20% increase in requirements. The U.S. requirements are used in the analysis to provide perspective regarding the quantities of material that DOE is considering for transfer relative to the markets into which they would be introduced.

2.2 Enrichment Services Supply

Sources and quantities of uranium enrichment services include existing inventories of LEU, production from existing uranium enrichment plants, enrichment services obtained by blending down Russian weapons grade HEU, recycle materials, primarily the use of plutonium in the form of mixed oxide (MOX) fuel, as well as announced new enrichment plants and expansions at existing facilities. The supply in this analysis also includes the annual amounts of Rosatom enrichment services that may be exported to the U.S. under the Amended Suspension Agreement directly to owners and/or operators of nuclear power plants or through USEC under the agreement that it executed last year with Tenex. The Amended Russian Suspension allows the import of EUP and SWU into the U.S. that is equivalent of up to 20% of nuclear power plant requirements starting in 2014.

The Georges Besse (GB-I) gas diffusion plant (GDP) operated by AREVA ceased operation in June 2012 and will undergo decommissioning. In November 2012, USEC reiterated its intention to close the Paducah GDP in May 2013. Even though there are published schedules for several sources of future supply that are in various stages of the licensing and construction process, it is currently unknown when these future supply sources will actually become operational; or whether one or more of these new facilities may encounter a problem of such significance that it may never be able to contribute to available supply. For example, (i) the construction and deployment schedule of the Eagle Rock Enrichment Facility (EREF) was placed on hold by AREVA in December 2011 as part of a corporate-wide reassessment of capital expenditures in reaction to significant budgetary pressures that had been building for several years; and (ii) the construction schedule for the USEC Advanced Centrifuge Plant (ACP) continues to be delayed due to problems revolving around USEC's ongoing difficulties in securing financing for the project.

Also, other presently operating facilities, such as Urenco's three operating enrichment facilities in Europe or its Urenco USA facility in the U.S., and Rosatom's four operating enrichment plants in Russia may be expanded in the future to meet projected, but as yet uncertain requirements, if they are needed. For example, in November 2012, Urenco USA submitted a license amendment to the U.S. Nuclear Regulatory Commission (NRC) to expand the capacity at the Urenco USA enrichment plant to 10 million SWU per year from the currently licensed capacity of 5.7 million SWU. The actual decision to expand the facility will be based on market conditions. In addition, the smaller enrichment plants that are located in countries such as Japan, China, Brazil and Argentina must also be considered, as must China's apparent plan to rapidly increase enrichment capacity by utilizing indigenous centrifuge technology.

Also, while they are not expected to be a significant source of supply in the long term, government HEU inventories currently play a role in meeting commercial requirements. Finally, General Electric Hitachi Nuclear Energy (GEH) has received a construction and operating license from the NRC that may lead to commercialization of the Global Laser Enrichment (GLE) Technology, which is based on Silex laser enrichment technology. If

GEH decides to proceed to commercialization of the GLE technology, this facility would provide an additional source of commercial supply at some point in the future.

2.3 Adequacy of Enrichment Supply Relative to Requirements

Figure 2.2 presents ERI's forecast of uranium enrichment supply and the ERI Reference Nuclear Power Growth requirements through 2035. Supply includes only existing capacity and firmly planned new capacity. The firmly planned new supply includes Urenco USA's ongoing expansion to 5.7 million SWU, AREVA GB II's expansion to 7.5 million SWU, JNFL's 1.5 million SWU replacing now retired capacity with an updated centrifuge design, and expansion of capacity by CNEIC to meet expanding domestic requirements.

As shown in the figure, modest amounts of additional new supply will be required beyond existing and firmly planned new supply for the ERI Reference Growth forecast. As discussed above, numerous new potential sources of enrichment supply are under various stages of design and licensing that could be used to meet the modest long-term supply gap shown in Figure 2.2. This supply will be brought to market when warranted by market conditions, that is, when sufficient long-term demand is apparent.

This figure also explicitly shows the contribution from the Russian HEU-derived LEU during the period through 2013, after which that source of equivalent enrichment supply is no longer present.

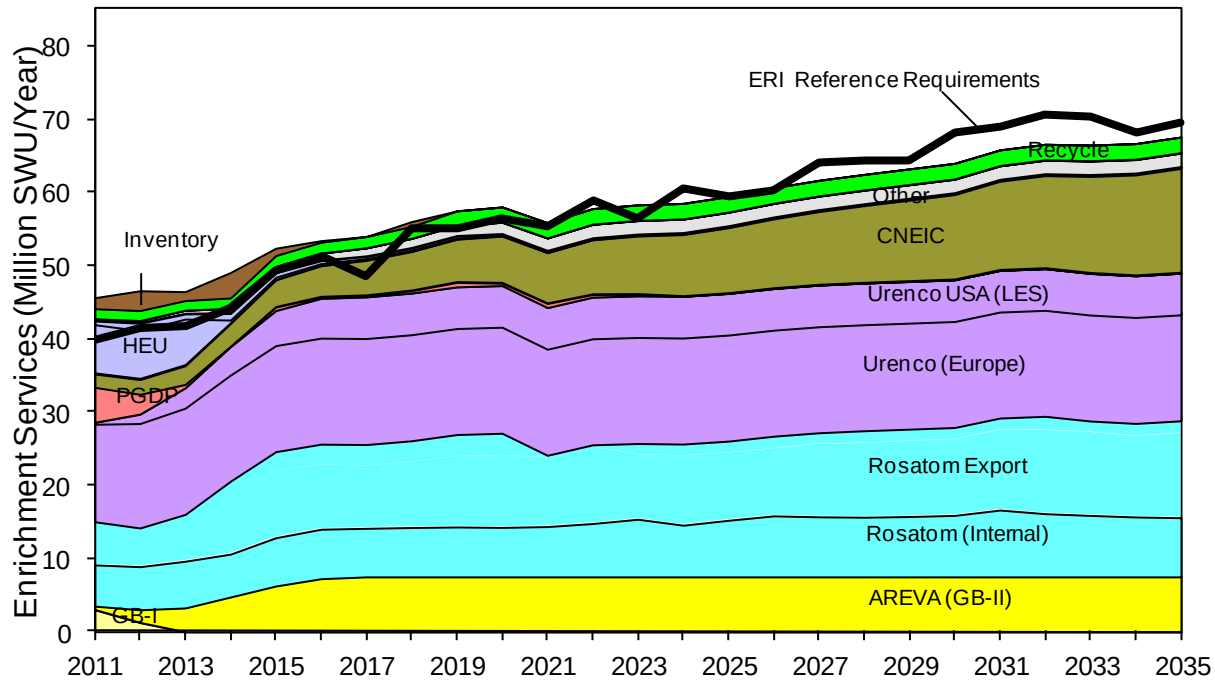

Figure 2.2 Forecast of World Supply and Requirements for Enrichment Services

During the 2013 to 2015 period, an average annual supply excess under the Reference Nuclear Power Growth forecast of approximately 4 million SWU, which is about 9% of requirements, is projected by ERI. Between 2016 and 2020, the average annual supply would exceed the Reference Nuclear Power Growth forecast by about 2.5 million SWU, which is about 5% of requirements during that period. Supply margins of 5% to 10% are consistent with historical enrichment market behavior. During 2021 to 2025 supply and demand are projected to be in equilibrium. However, without the addition of new supply, requirements exceed supply by an average of 2.3 million SWU per year during the period 2026 to 2035. As noted above, there are a number of sources that could potentially fill any supply deficits in the long-term and even beginning during the next couple of years if grown in requirements is greater than expected under the Reference Nuclear Power Growth forecast.

In summary, the enrichment market is expected to remain relatively in balance for the long term, but is oversupplied in the near term. A number of suppliers are capable of adding new capacity as needed, and with shorter construction lead times than typical of new nuclear power plants. The capital-intensive nature of enrichment technology discourages oversupply, but the number of suppliers able to expand incrementally should foster a healthy level of competition.

2.4 Summary of Published Market Prices

2.4.1 Enrichment Market Price Activity

Long-term prices for enrichment services began a steady rise from August 2004, with the long-term price indicator, as reported by TradeTech, reaching a plateau of $165 per separative work unit (SWU) in May 2009. The long-term price indicator declined to $160 per SWU in April 2010 and was essentially flat through August 2011 at $158 to $160 per SWU. While the long-term price held firm during the six months initially following the March 2011 accident at Fukushima, the impact of reduced Japanese demand combined with a weakening Euro has since caused the price to drift downward. The December 2012 long-term price of $135 per SWU represents a $23 per SWU or 11% price decline since August 2011.[10]

The spot market price indicator, as reported by TradeTech LLC, has generally mirrored the movements of the long term price indicator with one important difference. The spot market price now reflects a discount when compared to the long term market price indicator. The discount appeared in 2010 and was modest, averaging $4.50 per SWU or 3% of the long term price. The discount increased in the second half of 2011 and again in the second half of 2012, and is $15 per SWU or 11% of the long term price as of December 2012, with a spot market indicator of $120 per SWU as of December 2012. The discount is driven by

[10] References throughout this analysis to TradeTech market prices refer to prices published by TradeTech in its monthly publication, The Nuclear Review, dated December 2011 and December 2012, and a TradeTech weekly publication, Nuclear Market Review, dated January 4, 2013.

the current surplus of supplier capacity in conjunction with very low near term demand, as end-users are highly committed under their term contracts.

2.4.2 Future Market Price for Enrichment Services

Present market prices are believed to provide sufficient stimulus for the operation of existing centrifuge enrichment plant capacity as well as expansion at existing sites. Facility capital costs can be covered, financing guaranteed, and an adequate return on investment earned at these prices. There is some prospect for the commercial deployment of a new laser-based enrichment technology; which could lead to long-term price decreases; however, there has not yet been a commitment to deploy this technology. Under the Reference Nuclear Power Growth requirements forecast, long term prices for enrichment services in constant dollars are expected to decline a few percent but then remain stable.

A production cost analysis of enrichment facilities coupled with an economic market clearing price analysis results in the conclusion that for each additional million SWU of enrichment services that are added to supply in a year, there is the potential for a reduction in the market clearing price that is on average $3.50 per SWU during the three year span centered on 2013. It is important to note that this estimated impact is relative to the projected economic market clearing price, which serves as the basis for long-term price projections. More than 95% of the enrichment services requirements purchased during the period 2009 through 2012 have been purchased under term contracts.[11]

2.5 Market Price Volatility

Table 2.1 provides a summary of the total 12 month, and month-to-month volatility (i.e., absolute values of change), respectively, in published spot and term market prices for enrichment services, during the previous three year period, ending December 31, 2012.

	Average, Minimum and Maximum of Absolute Value of Annual Change in Market Price During Past Three Years		Absolute Value of Largest Month to Month Change in Market Price During Past Three Years		Average of Absolute Values of Month to Month Change in Market Price During Past Three Years	
	Change,Dollar Basis	Change,Percent Basis	Maximum Monthly Change, Dollar Basis	Maximum Monthly Change, Percent Basis	Average Monthly Change, Dollar Basis	Average Monthly Change, Percent Basis
Enrichment Services, $ per SWU						
Spot Market Price	$15.00 / $10.00 / $20.00	10.0% / 6.1% / 14.3%	$9.00	6.7%	$1.36	0.9%
Term Market Price	$10.00 / $7.00 / $13.00	6.5% / 4.2% / 8.8%	$6.00	4.0%	$0.83	0.5%
Source of market price data used to calculate volatility is Trade Tech						

Table 2.1 Summary of Nuclear Fuel Price Volatility for Enrichment Services

[11] Based on information published by The Ux Consulting Company, LLC in the Ux Weekly, to which DOE subscribes.

As shown in Table 2.1, the spot market price for enrichment services has shown downward price trends during the past three years. The average value of the annual changes during this period has been $15.00 per SWU, which represents an average annual change of 10.0% in the underlying spot market price. The minimum and maximum values of annual change in the spot market price of enrichment services during this period have been $10.00 (6.1%) and $20.00 (14.30%) per SWU, respectively. During this same period, the largest month to month change in spot market price is $9.00 per SWU, which is 6.7% of the underlying spot market price. The average month to month change in spot market price during these three years is $1.36 per SWU, which is 0.9% of the average spot market price during this period.

During this same period, the term price for enrichment services has behaved in a similar manner, showing even less volatility than that of the spot market price, as illustrated in Table 2.1.

3. DOE Material Being Considered for Transfer

DOE is considering a transaction involving the transfer of the SWU component contained in EUP to USEC, as discussed in more detail below. This transaction would take place in 2013. This transaction is discussed below in the context of other SWU transfers that would also occur in 2013 as previously analyzed in the 2012 Market Impact Assessment.

3.1 Proposed Transfer of SWU contained in DOE EUP to USEC

DOE is considering a transaction that involves the transfer of the SWU component contained in DOE EUP to USEC for which DOE will receive UF_6 and the value of the SWU contained in the EUP in return. Under the proposed transaction, DOE will provide 47,646 kg EUP to USEC and will receive in return from USEC 408,834 kg UF_6 at 0.711 w/o and the value of the 299,000 kg SWU contained in the EUP. The material that would be transferred into the commercial market is the 299,000 kg SWU contained in the EUP. No transfer of uranium to the commercial market is contemplated as part of this transaction. Therefore, the market impact assessed in this analysis is that to the enrichment services market only. There would be no market impact to the uranium or conversion markets associated with this transaction.

In March 2012, DOE and USEC signed a LEU sales agreement in which DOE purchased the same quantity of SWU, in the form of LEU, from USEC via a typical toll enrichment services transaction. In that 2012 transaction, $44 million of cash was returned to USEC that had been cash collateral supporting financial assurances for the disposition of a quantity of depleted uranium that was transferred to DOE in exchange for DOE acquiring LEU from USEC. DOE provided the natural UF_6 feed to USEC for enrichment.[12] Over the 2012 to 2013 time frame the net transfer of enrichment services to the commercial market from the March 2012 and proposed 2013 transaction will be zero. USEC is expected to deliver the SWU transferred from DOE in 2013 under an existing term contract, although a new spot market sale is also possible.

3.2 DOE Depleted UF6 Transfer

As discussed in the 2012 Market Impact Assessment, DOE is transferring up to 9,156 MTU of high assay DUF_6 to Energy Northwest (ENW) during the period 2012 and 2013. The transfer is being followed by enrichment of the DUF_6 to LEU by USEC through a contract with ENW. The 2012 Market Impact Assessment provided an analysis of the alternative paths that were under consideration by ENW and other parties for the introduction of this material into the commercial markets during the 20 year period, 2014 through 2033.

Regarding the timing for the use of the quantities of enrichment services content of the LEU that would be produced from the enrichment of this transferred DUF_6, all of the alternative paths considered would result in the first introduction of LEU beginning in

[12] USEC Updated Outlook for 2012 Financial Metrics, USEC Press Release, June 27, 2012.

2014.[13] The 2012 Market Impact Assessment made conservative assumptions regarding the impact of the LEU generated from the DUF_6 transfer. First, it was assumed that the enrichment services content of the LEU constituted new supply, even though the enrichment content is provided by existing supply capacity at the Paducah GDP. The basis for this assumption is that Paducah was expected to be shut down if the DUF_6 transfer by DOE did not occur[14]. A second conservative assumption made in the 2012 Market Impact Assessment was that no credit was taken for the introduction of a new requirement for enrichment services by the DUF_6 transfer. The DUF_6 requires 1.5 million SWU in order to be enriched to the 0.711 w/o U^{235} level of natural uranium. This represents a new demand on enrichment supply in 2012 and 2013. The DOE 2008 Plan treated the enrichment services required to enrich depleted uranium to natural levels as an offset to the other DOE sales and transfers of enrichment services.

3.3 DOE/NNSA Down Blended HEU Material

As discussed in the 2012 Market Impact Assessment, there are four elements of down blended HEU that are presently expected by NNSA to be transferred to the commercial markets:

- Tennessee Valley Authority (TVA) off-spec material;
- American Assured Fuel Supply (AFS) barter material for the NNSA contractor;
- Mixed Oxide (MOX) LEU Backup Inventory Project barter material for the NNSA contractor; and
- Unallocated HEU to be down blended in the future.

Table 3.1 presents a summary of the NNSA net equivalent quantities of enrichment services that DOE/NNSA expects to transfer in 2013, as previously presented in the 2012 Market Impact Assessment.[15]

According to DOE/NNSA, based on information that is presently available, the last transfer to TVA occurred in 2011 and the last transfer to the NNSA contractor that is down blending HEU for the AFS occurred during 2012. The last transfer to the NNSA contractor that is down blending HEU for the MOX LEU Backup Inventory Project will occur during 2013. The LEU to be down blended from presently unallocated HEU will not be introduced into the market prior to 2014.

[13] 2012 Market Impact Assessment, Table 3.1, Summary of Alternative Disposition Paths for DOE's High Assay DUF_6

[14] USEC INC 10Q Quarterly Report, page 26, May 2, 2012.

[15] These are referred to as being "net" amounts of materials and services since they account for the enrichment services that would be required to be purchased to enrich the depleted uranium tails that are identified in the DOE 2008 Plan, if they are to be characterized as natural uranium equivalent material.

	Equivalent Net Million SWU
TVA	0.00
Assured Fuel Supply	0.00
MOX Backup	0.45
Unallocated HEU	0.00
Total	0.45

Table 3.1 Summary of Presently Expected NNSA Transfers of Equivalent Net SWU

The information presented in Table 3.1 is based on when the material is transferred, including the off-spec material transfers to TVA. However, ERI believes that any potential market price 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.[16] Table 3.2 has been prepared to reflect the NNSA material, as adjusted to more appropriately represent the timing of potential impact on the commercial markets.

	Equivalent Net Million SWU
TVA	0.33
Assured Fuel Supply	0.00
MOX Backup	0.45
Unallocated HEU	0.00
Total	0.78

Table 3.2 Summary of Presently Expected NNSA Transfers of Equivalent Net SWU Based on Year of Potential Impact

The quantities of equivalent net enrichment services presented in Table 3.1 may be used to compare with the 10% guideline discussed in Section 1; and those in Table 3.2 will serve as the basis for ERI estimating potential market price impact.

[16] 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.

3.4 Summary of 2013 Equivalent Net Enrichment Services Presently Considered for Transfer

The enrichment component of the LEU being considered for transfer to USEC in 2013, and the enrichment component of the NNSA transfers of down blended HEU equivalent account for 40%, and 60%, respectively, of the enrichment component of total DOE material under consideration for transfer in 2013. During 2013, there would be no transfer to the market of the enrichment component of LEU that would result from enrichment of transferred high assay depleted UF_6. Table 3.3 summarizes the total equivalent new SWU to be transferred in 2013 associated with each of these transfers and as a percentage of annual U.S. nuclear fuel requirements.

SWU Component of Transfers in 2013	Equivalent Net Million SWU	Percentage of U.S. Requirements in 2013
DOE Depleted UF_6	0.00	0.0%
DOE/NNSA Transfers	0.45	3.1%
Transfer of SWU to USEC	0.30	2.1%
Total	0.75	5.2%
DOE Depleted UF_6 Offset	-0.65	-4.5%
Net Total	0.10	0.7%

Table 3.3 Total Equivalent Net Million SWU to be Transferred in 2013

As shown in Table 3.3, two of the three types of material transfers by DOE involving the transfer of equivalent enrichment services would take place in 2013: (1) DOE/NNSA transfers (0.45 million equivalent net SWU) and (2) transfer of 0.30 million equivalent net SWU to USEC that is the subject of this report. These two transfers of equivalent enrichment services in 2013 would total 0.75 million equivalent net SWU and would represent 5.2% of U.S. requirements in 2013. This represents a conservative estimate of the net quantity of DOE material transferred to the commercial enrichment market, as it does not include an offset for the enrichment services used to enrich DOE DUF_6 during 2013[17]. The net total quantity transferred to the commercial enrichment market in 2013 is 0.10 million SWU, or 0.7% of U.S. requirements, when a -0.65 million SWU offset for DUF_6 re-enrichment is included for 2013.

[17] The DUF6 is re-enriched between June 1, 2012 and May 31, 2013. If 1.5 million SWU are required in total to enrich to natural uranium, the 2013 pro-rata share is then 0.65 million SWU.

4. QUANTIFICATION OF THE POTENTIAL EFFECT OF THE TRANSFER OF DOE MATERIAL

4.1 Potential Effect of Transfers on Market Prices

The potential effect on term market price for enrichment services can be estimated by applying the results of ERI's economic market clearing price analysis for enrichment services to the incremental amount of equivalent enrichment services that would result from DOE's transfers of equivalent enrichment services in 2013. ERI's market clearing price analysis for enrichment services is summarized in Section 2.4.2, regarding the potential impact of an incremental addition of enrichment services supply on the market clearing price of enrichment services. In that analysis, ERI determined that for each additional million SWU of enrichment services that are added to supply in 2013, there is the potential for a reduction in the market clearing price that is on average $3.50 per SWU. Thus, assuming the 0.78 million equivalent net SWU associated with expected NNSA transfers from Table 3.2 (based on when material would be loaded into TVA reactors) plus the 0.3 million equivalent net SWU associated with the transfer by DOE of the SWU component contained in LEU to USEC, for total transfers in 2013 of 1.08 million SWU. This would result in a potential impact on term market prices of enrichment services of an estimated $3.70 per SWU, equivalent to 2.7% of the current term price. The incremental impact on term market prices of just the 0.3 million SWU transfer is an estimated $1.05 per SWU, equivalent to 0.8% of the current term price. If credit is taken for the enrichment services required to re-enrich DUF_6 to natural levels during 2013, then the net transfer is 0.65 million SWU and the potential impact on term market prices of enrichment services of all DOE transfers is an estimated $1.40 per SWU, equivalent to 1.0% of the current term price.

4.2 Comparison of Potential Market Price Impact with Market Volatility Data

In order to provide further perspective regarding the potential impact on market prices of the quantities of equivalent net enrichment services to be transferred in 2013, Table 4.1 provides comparisons of the potential impacts on market prices relative to the month-to-month volatility in the published market price indicators, as had been previously shown in Table 2.1 over the last three years, for the transfers that are under consideration in 2013. The potential price impact shown in the table is for the quantity transferred prior to any DUF_6 re-enrichment offset.

	Absolute Value of Largest Month to Month Change in Market Price During Past Three Years		Average of Absolute Values of Month to Month Change in Market Price During Past Three Years		Potential Impact on Market Clearing Price of Enrichment Services Associted with DOE Transfers in 2013	
	Maximum Monthly Change, Dollar Basis	Maximum Monthly Change, Percent Basis	Average Monthly Change, Dollar Basis	Average Monthly Change, Percent Basis	Change, Dollar Basis	Change, Percent Basis
Spot Market Price	$9.00	6.7%	$1.36	0.9%	-	-
Term Market Price	$6.00	4.0%	$0.83	0.5%	$3.78	2.8%
Source of market price data used to calculate volatility is Trade Tech monthly publication, The Nuclear Review.						

Table 4.1 Comparison of Potential Effect on Market Clearing Price for Enrichment Services Relative to Monthly Price Volatility Data

As also shown in Table 4.1, the potential impact on the term price for enrichment services is $3.78 per SWU in 2013, which is less than the maximum month-to-month change experienced during the past three years, as well as the total change in price over any of the last three years; and equivalent to four-and-a-half months of the average month-to-month volatility in the term price for enrichment services. When the offset for DUF_6 re-enrichment is included, the potential price impact is equivalent to less than two months of the average month-to-month volatility in the term price for enrichment services.

It is noted that (i) the total spot market volume for enrichment services is estimated to have been on average less than 1.5 million SWU per year during the period 2009 through 2012[18], which represents less than 4% of annual world total requirements for enrichment services; and (ii) that, it is generally not common to reference to the spot market price indicators in term contracts for enrichment services. Therefore, the potential impact of DOE transfers on the spot market price for enrichment services is not viewed as being an indicator of market impact on the enrichment industry. In summary, the potential impact on market price of the DOE material transfer is consistent with the historical volatility observed in the nuclear fuel markets.

4.3 Potential Impact on the Domestic Enrichment Services Industry

From a market perspective, the proposed transaction reverses DOE's March 2012 purchase of enrichment services from USEC. Under this transaction, only SWU would be introduced into the commercial market, but no transfer of natural uranium to the commercial market would take place. Other than USEC, Urenco USA is the only U.S. company that can enrich uranium during 2013. Urenco USA is ramping up production at its enrichment facility located in New Mexico, with virtually all of its 2013 enrichment capacity committed under contract. DOE transfers would not displace these already committed sales by the domestic

[18] Based on information published by The Ux Consulting Company, LLC in the Ux Weekly, to which DOE subscribes.

industry. As for USEC, it is clear that the company supports and will benefit from the transfer 0.3 million SWU that is under consideration by DOE. In addition, it should be noted that the NNSA/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.

Therefore, the potential impact of the transfer of DOE material presently under consideration on the enrichment services industry is not significant.

The transfer of an additional 0.3 million SWU in 2013, when assessed in conjunction with other possible transfers of equivalent new enrichment services into the market by DOE, results in a total transfer to the commercial market that remains well below 10% of U.S. enrichment requirements in 2013. The total to be transferred to the commercial markets from HEU down blend remains consistent with the representative amount for 2013 originally projected in the DOE 2008 Plan, as does the net total from all DOE transfers of enrichment services.[19]

In summary, based on presently available information and the results of the analysis described in this report, ERI does not believe that either (i) the potential price effect associated with the transfer by DOE of an additional 0.3 million SWU to USEC during 2013; or (ii) the quantities of domestic enrichment services, if any, that might be displaced due to the proposed DOE transfers are of a magnitude that they would constitute a material adverse impact on the domestic enrichment industry, taking into account the sales of uranium under the U.S.-Russia Highly Enriched Uranium Agreement (HEU Agreement) and the Suspension Agreement.

[19] Table 9 of the plan projected 0.787 million SWU from Allocated HEU Down-blend during 2013, with an offset of -0.586 million SWU for DUF_6 processing.

GLOSSARY

ACP – USEC's planned American 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 – 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.

EREF – AREVA's planned Eagle Rock Enrichment Facility.

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 – 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.