DEPARTMENT OF ENERGY

Excess Uranium Management: Secretarial Determination of No Adverse Impact on the Domestic Uranium Mining, Conversion, and Enrichment Industries

AGENCY: Office of Nuclear Energy, Department of Energy.

ACTION: Notice.

SUMMARY: On May 1, 2015, the Secretary of Energy issued a determination (''Secretarial Determination'') covering continued transfers of uranium for cleanup services at the Portsmouth Gaseous Diffusion Plant and for down-blending of highly-enriched uranium to low-enriched uranium. The Secretarial Determination covers transfers of up to the equivalent of 2,500 metric tons of natural uranium (''MTU'') per year in 2015 and up to the equivalent of 2,100 MTU in each year thereafter. For the reasons set forth in the Department's ''Analysis of Potential Impacts of Uranium Transfers on the Domestic Uranium Mining, Conversion, and Enrichment Industries,'' which is incorporated into the determination, the Secretary determined that these transfers will not have an adverse material impact on the domestic uranium mining, conversion, or enrichment industry.

DATES: Effective May 1, 2015.

ADDRESSES: The 2015 Secretarial Determination and supporting documents are available on the Department's Web site at *http://www.energy.gov/ne/downloads/2015-secretarial-determination.*

FOR FURTHER INFORMATION CONTACT: Mr. David Henderson, U.S. Department of Energy, Office of Nuclear Energy, Mailstop NE–52, 19901 Germantown Rd., Germantown, MD 20874–1290. Phone: (301) 903–2590. Email: *David.Henderson@Nuclear.Energy.Gov.*

SUPPLEMENTARY INFORMATION: The Department of Energy (DOE) holds inventories of uranium in various forms and quantities—including low-enriched uranium (LEU) and natural uranium—that have been declared as excess and are not dedicated to U.S. national security missions. Within DOE, the Office of Nuclear Energy (NE), the Office of Environmental Management (EM), and the National Nuclear Security Administration (NNSA) coordinate the management of these excess uranium inventories. Much of this excess uranium has substantial economic value on the open market. One tool that DOE has used to manage its excess uranium inventory has been to enter into transactions in which DOE exchanges excess uranium for services. This notice involves uranium transfers of this type under two separate programs. Specifically, DOE transfers uranium in exchange for cleanup services at the Portsmouth Gaseous Diffusion Plant and for down-blending of highly-enriched uranium to LEU.

These transfers are conducted in accordance with the Atomic Energy Act of 1954 (42 U.S.C. 2011 *et seq.,* ''AEA'') and other applicable law. Specifically, Title I, Chapters 6–7, 14, of the AEA authorize DOE to transfer special nuclear material and source material. LEU and natural uranium are types of special nuclear material and source material, respectively. The USEC Privatization Act (Pub. L. 104–134, 42 U.S.C. 2297h *et seq.*) places certain limitations on DOE's authority to transfer uranium from its excess uranium inventory. Specifically, under section 3112(d)(2) of the USEC Privatization Act (42 U.S.C. 2297h–10(d)(2)), the Secretary must determine that the transfers ''will not have an adverse material impact on the domestic uranium mining, conversion or enrichment industry, taking into account the sales of uranium under the Russian Highly Enriched Uranium Agreement and the Suspension Agreement'' before DOE makes certain transfers of natural or low-enriched uranium under the AEA.

On May 1, 2015, the Secretary of Energy determined that continued uranium transfers for cleanup services at Portsmouth and down-blending services will not have an adverse material impact on the domestic uranium mining, conversion, or enrichment industry (''2015 Secretarial Determination''). This determination covers transfers of up to the equivalent of 2,500 metric tons of natural uranium (''MTU'') per year in 2015 and up to the equivalent of 2,100 MTU in each year thereafter. The Secretary based his conclusion on the Department's ''Analysis of Potential Impacts of Uranium Transfers on the Domestic Uranium Mining, Conversion, and Enrichment Industries,'' which is incorporated into the determination. The Secretary considered, *inter alia,* the requirements of the USEC Privatization Act of 1996 (42 U.S.C. 2297h *et seq.*), the nature of uranium markets, and the current status of the domestic uranium industries, as well as sales of uranium under the Russian HEU Agreement and the Suspension Agreement. This Determination replaces the previous determination issued in May 2014, which covered transfers for these two programs of up to the equivalent of 2,705 MTU per year.

The full text of the 2015 Secretarial Determination is set forth below.

Issued in Washington, DC, on May 1, 2015.

Peter B. Lyons,

Assistant Secretary for Nuclear Energy, Office of Nuclear Energy.

Set forth below is the full text of the Secretarial Determination.

Secretarial Determination for the Sale or Transfer of Uranium

Since May 15, 2014, the Department of Energy (''Department,'' ''DOE'') has transferred natural uranium and low-enriched uranium in specified amounts and transactions, subject to a determination I made on that date pursuant to § 3112(d)(2) of the USEC Privatization Act, 42 U.S.C. 2297h-10(d) (''2014 Determination''). For the reasons provided herein, the 2014 Determination is replaced by the determination described below, and no further transfers pursuant to the 2014 Determination will take place.

The 2014 Determination covered transfers of up to the equivalent of 2,705 metric tons of natural uranium (''MTU'') per year, in natural uranium hexafluoride provided to contractors for cleanup services at the Paducah or Portsmouth Gaseous Diffusion Plant and in low-enriched uranium transferred to contractors for down-blending highly enriched uranium. The 2014 Determination concluded that the transfers it described would not have adverse material impacts on the domestic uranium industries. In issuing this determination to supersede the 2014 Determination, I do not repudiate that conclusion or invalidate transfers made pursuant to the 2014 Determination.

However, after balancing the Department's goals regarding the projects being partly supported by uranium transactions with the Department's goal to help maintain healthy domestic nuclear industries, and reviewing responses to the Department's solicitations for public input, I have concluded that the lower rates of uranium transfers described herein are appropriate in the near term. I have therefore determined to permit transfers only at the lower rates described below. To avoid disruption to the projects involved, the Department will continue transferring at the pre-existing rates for approximately two months, as described below.

Accordingly, I determine that the following transfers will not have an adverse material impact on the domestic

mining, conversion, or enrichment industry:

(1) In calendar year 2015, up to 2,000 MTU contained in natural uranium hexafluoride, transferred to contractors for cleanup services at the Portsmouth Gaseous Diffusion Plant, in transfers of up to 600 MTU per quarter until June 30, 2015 and up to 400 MTU per quarter for the remainder of 2015; and

(2) in calendar year 2016 and thereafter, up to 1,600 MTU per calendar year contained in natural uranium hexafluoride, transferred to contractors for cleanup services at the Portsmouth Gaseous Diffusion Plant, in transfers of up to 400 MTU per quarter; and

(3) in calendar year 2015 and thereafter, an amount of low-enriched uranium equivalent to up to 500 MTU of natural uranium per calendar year, transferred to contractors for down-blending highly-enriched uranium to low-enriched uranium;

PROVIDED THAT

(4) in the event transfers of low-enriched uranium do not reach the equivalent of 500 MTU of natural uranium in any calendar year, transfers of natural uranium may exceed 400 MTU in the fourth quarter of that calendar year so long as the total amount transferred by the Department does not exceed the equivalent of 2,500 MTU of natural uranium in calendar year 2015 or the equivalent of 2,100 MTU of natural uranium in a subsequent year.

I base my conclusions on the Department's ''Analysis of Potential Impacts of Uranium Transfers on the Domestic Uranium Mining, Conversion, and Enrichment Industries,'' which is incorporated herein. As explained in that document, I have considered, *inter alia,* the requirements of the USEC Privatization Act of 1996 (42 U.S.C. 2297h *et seq.*), the nature of uranium markets, and the current status of the domestic uranium industries. I have also taken into account the sales of uranium under the Russian HEU Agreement and the Suspension Agreement.

Date: May 1, 2015.

Ernest J. Moniz,

Secretary of Energy.

Analysis of Potential Impacts of Uranium Transfers on the Domestic Uranium Mining, Conversion, and Enrichment Industries

May 1, 2015

Executive Summary

The Department of Energy (''Department'' or ''DOE'') plans to transfer the equivalent of up to 2,100 metric tons (''MTU'') of natural uranium per year (with a higher total for calendar year 2015, mainly because of transfers already executed or under way before today's determination). These transfers would include 1,600 MTU in natural uranium hexafluoride transferred in exchange for cleanup services at the Portsmouth Gaseous Diffusion Plant; and low-enriched uranium, at an assay of 4.95 wt-% U–235, equivalent to 500 MTU of natural uranium, transferred for services to down-blend highly enriched uranium. In support of a determination whether these transfers will have an adverse material impact on the domestic mining, conversion, or enrichment industry, the analysis below assesses the potential impacts of DOE's transfers. It takes account of the transfers just described as well as past DOE transfers still affecting the markets and certain transfers contemplated for later years.

For purposes of the Department's determination, transfers will have an ''adverse material impact'' when a reasonable forecast predicts that an industry will experience ''material'' harm that is reasonably attributable to the transfers. To test that attribution, the analysis compares the expected state of each industry in light of the planned transfers to what would happen in the absence of transfers. Such ''but-for'' analysis identifies what impacts DOE's transfers can be said to cause. As a corollary proposition, the analysis does not conclude that transfers would be impermissible solely because an industry is weak. Conversely, it also does not regard transfers as permissible so long as they are not the sole or primary cause of an industry's problem. The analysis must reflect existing conditions, whether prosperous or difficult; and the proper question is to what degree the effects of DOE's transfers would make an industry weaker.

Not every impact will be an ''adverse material impact'' for these purposes. In general, the Department regards an ''adverse material impact'' as a harm of real import and great consequence, beyond the scale of what normal market fluctuations would cause.

The analysis evaluates six factors for each industry: changes to prices; changes in production levels at existing facilities; changes to employment in the industry; changes in capital improvement plans; the long-term viability of the industry; and, as required by statute, sales under certain agreements permitting the import of Russian-origin uranium. The analysis relies on myriad inputs, including a study prepared for the Department by consultant Energy Resources International, Inc., market data and forecasts from several sources, reports by other market consultants, and additional submissions in response to the Department's requests for comment.

The uranium mining industry serves the market for uranium concentrates. DOE's transfers, including those described above, constitute less than 4% of global demand for uranium concentrates. The Department forecasts, on the basis of consonant results from multiple economic models that these transfers will tend to suppress prices (on average over a 10 year period) by about $2.70 per pound. While this price effect will decrease producers' revenues, the near-term impact will be smaller because most producers primarily sell on long-term contracts and therefore have limited exposure to price fluctuations. The impact on production and employment in the industry will also be limited. As prices increase over the coming decade, there appears to be little domestic production for which DOE's transfers would make the difference between expansion and contraction. In the long-term, the Department concludes that the effect of its transfers would delay decisions to expand or increase production capacity but would not change the eventual outcomes.

The uranium conversion industry processes uranium concentrates into uranium hexafluoride suitable for enrichment. Most conversion is sold on long-term contracts, and the sole domestic converter makes essentially all its sales that way. The distinctive feature of the conversion market is that the price for long-term contracts appears not to be the product of ordinary market forces. It has been stable for five years despite market changes that have caused the prices for uranium and enrichment to change by 50% or more, and despite the fact that none of the major converters in Western countries is producing at full capacity. These conditions arise in part because conversion is a key step in the nuclear fuel cycle, but one that makes up fairly little of the overall price of uranium fuel. At the same time, most of the costs of conversion are fixed costs. It appears that fuel customers are willing to pay the prices converters demand to secure long-term supplies. In light of these conditions, the Department concludes that the term price will remain stable despite DOE's transfers. Transfers will tend to cause a suppression of the global spot price by about $0.70 per kgU, but the domestic industry has no or almost no exposure to the spot price. DOE assumes the domestic industry will lose

some sales as a consequence of DOE-sourced material's appearing on the market. Those sales will reduce the industry's revenues. But if the decrease in production were to increase average costs above current term prices, the industry would be able to increase prices correspondingly. The Department also concludes that its transfers will have, at most, limited impact on employment and plans for capital improvement and expansion. As it did with respect to the uranium mining industry, the Department concludes that the effect of its transfers would, at worst, slightly delay decisions to undertake major capital improvements or capacity expansions.

The enrichment industry applies enrichment capacity to produce low-enriched uranium. It can also, by appropriate use of enrichment capacity, conserve natural uranium (through a mechanism called ''underfeeding'') and effectively generate additional uranium supply. On the basis of several different models, DOE forecasts that its transfers will cause a price suppression of about $5.25 per SWU (separative work units, the unit for measuring enrichment services) in the near term and $5.40 per SWU over the longer term. The vast majority of enrichment is sold on long-term contracts, and indeed an enrichment provider typically will not invest in capacity without having such contracts in hand. The sole domestic enricher began operations in 2008, and contracts typically last 10 years or more. The domestic industry therefore has little exposure to current prices for enrichment. Because enrichers can also sell conserved natural uranium, a suppression of uranium concentrate and conversion prices can also affect their revenues. But that impact should be relatively small because natural-uranium sales consume only 10–15% of enrichment capacity. The Department also concludes that because enrichment facilities cannot easily decrease capacity, DOE transfers will not cause changes in production levels or employment at existing facilities. In the longer term, DOE's transfers will not significantly affect investment decisions because substantially higher prices would be needed to justify investment than could be obtained without market growth, even absent DOE's transfers. As it did with respect to the mining and conversion industries, the Department concludes that the effect of its transfers would, at most, slightly delay decisions to construct additional capacity.

The Department recognizes that market conditions have been difficult in recent years for all three industries. But its analytical task under section 3112(d)(2) is to forecast what additional harm industry would suffer that can reasonably be attributed to its transfers of uranium. The Department concludes that the potential impacts to the domestic uranium mining, conversion, and enrichment industries from transfers at the rates described above are not so great as to constitute adverse material impacts.

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I. Introduction

A. Review of Procedural History

In preparation for this Secretarial Determination, DOE sought information from the public through a Request for Information (RFI) published in the **Federal Register** on December 8, 2014 (79 FR 72661). DOE specifically requested comment on the effects of continued uranium transfers on the domestic uranium industries and recommendations about factors to be considered in assessing the possible impacts of DOE transfers. In response to the RFI, DOE received comments from a diverse group of parties representing interests across the nuclear industry. DOE also received comments from trade associations, nuclear utilities, local governmental bodies, and members of the public.

In addition, DOE tasked Energy Resources International, Inc., (ERI) to assess the potential effects on the domestic uranium mining, conversion, and enrichment industries of the introduction of DOE excess uranium inventory in various forms and quantities through sale or transfer during calendar years 2015 through 2024 (''2015 ERI Report''). This study also updated an earlier analysis that ERI prepared prior to the May 2014 Secretarial Determination [1] (''2014 ERI Report'').

On March 18, 2015, DOE published a Notice of Issues for Public Comment (NIPC) in the **Federal Register** (80 FR 14107). That notice announced the public availability of comments received in response to the December 2014 Request for Information, 2015 ERI Report, and a list of factors for analysis of the impacts of DOE transfers on the uranium mining, conversion, and enrichment industries. DOE received comments from members of the uranium mining, conversion, and enrichment industries, trade associations, and DOE contractors.[2]

B. Legal Authority

DOE manages its excess uranium inventory in accordance with the Atomic Energy Act of 1954 (42 U.S.C. 2011 *et seq.,* ''AEA'') and other applicable law. Specifically, Title I, Chapters 6–7, 14, of the AEA authorize DOE to transfer special nuclear material and source material. Low-enriched uranium (LEU) and natural uranium are types of special nuclear material and source material, respectively.

The USEC Privatization Act (Pub. L. 104–134, 42 U.S.C. 2297h *et seq.*) places certain limitations on DOE's authority to transfer uranium from its excess uranium inventory. Specifically, under section 3112(d) of the USEC Privatization Act (42 U.S.C. 2297h–10(d)), DOE may make certain transfers of natural or low-enriched uranium if the Secretary determines that the transfers ''will not have an adverse material impact on the domestic uranium mining, conversion or enrichment industry, taking into account the sales of uranium under the Russian Highly Enriched Uranium Agreement and the Suspension Agreement.'' 42 U.S.C. 2297h–10(d)(2)(B). The validity of any determination under this section is limited to no more than two calendar years subsequent to the determination. *See* Section 306(a) of Division D, Title III of the Consolidated and Further Continuing Appropriations Act, 2015 (Pub. L. 113–235).

Section 3112 of the USEC Privatization Act also contains

[1] The May 2014 Secretarial Determination is available on DOE's Web site at: *http://www.energy.gov/articles/energy-department-announces-secretarial-determination-no-adverse-material-impact-uranium.*

[2] The 2014 ERI Report, the 2015 ERI Report, and the comments received in response to the RFI and the NIPC are available at *http://www.energy.gov/ne/downloads/excess-uranium-management.* Some comments were marked as containing confidential information. Those comments are provided with confidential information removed.

provisions covering transfers of enriched uranium to other federal agencies, § 2297h–10(e)(1), to any person for national security purposes, § 2297h–10(e)(2), and to State or local agencies or nonprofit, charitable, or educational institutions, § 2297h–10(e)(3). For transfers to these entities, the Act does not require that the Secretary determine that there will not be an adverse material act on the domestic uranium industries. Other subsections of section 3112 cover transfers related to the down-blending of Russian highly enriched uranium. § 2297h–10(b).

C. Brief History of DOE Transfers

1. 2008 Plan

In March 2008, then-Secretary of Energy Bodman released a Policy Statement outlining a framework within which DOE intended to make decisions concerning use and disposition of its excess uranium inventory (''2008 Policy Statement'').[3] The Policy Statement observed that uranium DOE possesses ''is a valuable commodity both in terms of monetary value and the role it could play in achieving vital Departmental missions and maintaining a healthy domestic nuclear infrastructure,'' and it laid out certain principles for managing the inventory prudently to achieve those values. The 2008 Policy Statement established that the Department would engage, when appropriate, in transactions in which it would exchange uranium for services or for other uranium. All transactions involving transfers or sales outside the Government, the Statement noted, must provide ''reasonable value'' for the Department. ''Reasonable value takes into account market value, as well as other factors such as the relationship of a particular transaction to overall Departmental objectives and the extent to which costs to the Department have been or will be incurred or avoided.'' The Policy Statement declared that DOE would maintain sufficient uranium inventories to meet its own needs and would sell or transfer only uranium excess to those needs. In addition, the Policy Statement asserted that DOE would manage its uranium ''in a manner that is consistent with and supportive of the maintenance of a strong domestic nuclear industry.'' In that vein, the Statement noted 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.'' 2008 Policy Statement, at 2.

Based on this policy statement, in December 2008 DOE released its Excess Uranium Inventory Management Plan providing a comprehensive inventory of its excess uranium and details about DOE's preliminary plans for future management of its excess uranium inventory (''2008 Plan''). DOE's excess uranium inventory in 2008 consisted of highly enriched uranium (HEU), natural uranium hexafluoride (UF_6) of various origins, uranium of various enrichments in forms other than UF_6 that does not meet commercial specifications (''off-spec non-UF_6''), and depleted uranium in the form of UF_6. The volumes of these inventories at the time of the issuance of the 2008 Plan are listed in Table 1. The 2008 Plan identified several transactions that were ongoing, planned, or under consideration for disposition of DOE's excess uranium.

TABLE 1—EXCESS URANIUM INVENTORY FROM TABLE 1 OF 2008 PLAN

Inventory	Amount (in MTU)	Natural uranium equivalent (in MTU)
Unallocated HEU[4]	67.6	12,440
U.S.-origin natural UF_6	5,156	N/A
Russian-origin natural UF_6	12,440	N/A
Off-spec non-UF_6[5]	4,461	2,900
Depleted UF_6[6]	75,300	25,950

2. Recent Uranium Transfers

Since 2008, DOE has managed its inventory in accordance with the 2008 Policy Statement and Plan. The survey below includes the transfers involving the largest volumes, which are the ones most relevant for assessing how DOE's transfers have affected uranium markets.

DOE's National Nuclear Security Administration (NNSA) has transferred LEU down-blended from HEU (''blended LEU,'' or ''BLEU'') to the Tennessee Valley Authority for use in its Brown's Ferry Nuclear Plant. This program is discussed below in Section I.D.2.a. DOE and NNSA have also been transferring a small amount of high-assay LEU (*i.e.* above 5 wt-% U–235) to foreign and domestic research reactors. This program is discussed below in Section I.D.2.e.

In 2008, NNSA began an additional program of down-blending approximately 12.1 metric tons of HEU. In the course of this program, NNSA has transferred a portion of the resulting LEU to the contractor in exchange for the down-blending services. Prior to the start of this program the Secretary determined in October 2008 that the transfer of LEU in exchange for the down-blending of up to 12.1 metric tons of HEU would not have an adverse material impact on the domestic uranium mining, conversion, or enrichment industries. The amount of derived LEU was expected to be equivalent to approximately 336 MTU of natural uranium. 2008 Plan, at 11. NNSA is currently engaged in a successor program to down-blend another 3 metric tons of HEU, and the transfers considered in this analysis include further LEU in exchange for the down-blending services.

In July 2009, DOE announced that it would accelerate cleanup efforts at the Portsmouth Gaseous Diffusion Plant through increased funding and through transferring uranium in exchange for cleanup services. Beginning in

[3] The 2008 Policy Statement and the 2008 Excess Uranium Inventory Management Plan are available at *http://www.energy.gov/ne/downloads/excess-uranium-inventory-management-plan-2008.*

[4] The 2008 Plan explained that ''unallocated'' means HEU that ''is not presently obligated or approved for a specific purpose or DOE program.'' 2008 Plan, at 1 n.1.

[5] 1,680 MTU of this material is either natural or low-enriched. The remaining amount is depleted. The figure for the natural uranium equivalent of this material includes only the natural and low-enriched uranium.

[6] The quantity of depleted uranium includes only the UF_6 with an assay above 0.35 wt-% U–235.

November 2009, DOE's Office of Environmental Management (EM) transferred up to 300 MTU per quarter of natural uranium hexafluoride to the contractor at Portsmouth. Transfers during the period of November 2009 to December 2010 were limited to no more than 1,125 MTU, in accordance with the Secretary's determination in November 2009 that these transfers up to those rates would not have an adverse material impact on the domestic uranium mining, conversion, or enrichment industries.

Beginning in March 2011, EM transferred uranium for cleanup services at Portsmouth at an increased rate of 450 MTU per quarter. These transfers were conducted in accordance with the Secretary's Determination in March 2011 that such transfers between the first quarter of 2011 and the end of calendar year 2013 would not have an adverse material impact on the domestic uranium mining, conversion, or enrichment industry. Transfers during this period were limited to no more than 1,605 MTU per calendar year.

Beginning in 2012, EM transferred uranium for cleanup services at Portsmouth at an increased rate of 600 MTU per quarter and no more than 2,400 MTU per year. NNSA also extended its program of transferring LEU in exchange for down-blending services. The rate of transfers for down-blending after May 2012 was equivalent to 400 MTU of natural uranium. These transfers were conducted in accordance with the Secretary's determination in May 2012 that the sale or transfer of these amounts of uranium would not have an adverse material impact on the domestic uranium mining, conversion, or enrichment industries. In addition to these transfers, DOE also transferred in 2012 and 2013 approximately 9,156 MTU of depleted uranium to Energy Northwest. This transfer was included in the May 2012 Secretarial Determination and is discussed further in Section I.D.2.b.

In March 2013, DOE transferred approximately 48 MTU of LEU to USEC Inc. in exchange for an amount of natural uranium hexafluoride equivalent to the feed component of that LEU—409 MTU—and the value of approximately 299,000 SWU of enrichment services. The value of these services was retained by USEC to fund a portion of DOE's cost share under a 2012 Cooperative Agreement between DOE and USEC. This transfer was conducted in accordance with the Secretary's March 2013 determination that the sale or transfer of this uranium would not have an adverse material impact on the domestic uranium mining, conversion, or enrichment industries.

3. 2013 Plan

In July 2013, the Secretary issued a revised Excess Uranium Inventory Management Plan (''2013 Plan''), based on an updated inventory of the Department's uranium as of December 31, 2012.[7] This updated inventory is summarized in Table 2.

TABLE 2—EXCESS URANIUM INVENTORY FROM TABLE 1 OF 2013 PLAN

Inventory	Amount (in MTU)	Natural uranium equivalent (in MTU)
Unallocated HEU	18.0	3,394
Allocated HEU	11.4	2,077
LEU	47.6	409
U.S.-origin natural UF_6	5,234	N/A
Russian-origin natural UF_6	7,705	N/A
Off-spec LEU as UF_6	1,106	1,876
Off-spec non-UF_6[8]	221	600
Depleted UF_6[9]	114,000	25,000–35,000

The 2013 Plan reaffirmed the Department's goals of maintaining sufficient inventories to meet DOE needs, transacting ''in a transparent and competitive manner,'' and managing inventories in a manner ''consistent with and supportive of the maintenance of a strong domestic uranium industry.'' The plan included the transfer of enriched uranium to pay for down-blending of HEU to LEU and the transfer of natural uranium in exchange for cleanup services at the Portsmouth Gaseous Diffusion Plant through 2021. 2013 Plan, 13–15. The 2013 Plan also announced that DOE would no longer use the ten percent guideline established in the 2008 Policy and Plan. The 2013 Plan explained that DOE's experience between 2008 and 2013, including a 2012 market impact analysis and a 2009 Finding of No Significant Impact and Mitigation Action Plan, led it to determine that DOE ''can meet its statutory and policy objectives in regard to DOE uranium sales or transfers without an established guideline.'' In addition, the plan noted that in light of the two-year limit on the validity of a determination under section 3112(d), an established guideline was no longer necessary.

4. 2014 Determination

On May 15, 2014, the Secretary determined that sales or transfers of a total of 2,705 MTU per calendar year will not have an adverse material impact on the domestic uranium mining, conversion, or enrichment industries (''2014 Secretarial Determination''). The 2,705 MTU was broken down as follows:

- Up to 2,055 MTU per year to DOE contractors for cleanup services at the Paducah or Portsmouth Gaseous Diffusion Plant, in quarterly transfers of up to 600 MTU for the period 2014 through 2021;
- Up to 650 MTU per year to the National Nuclear Security Administration (NNSA)'s contractors for down-blending of HEU to LEU for the period 2014 through 2022;
- Provided that, in the event down-blending transfers do not reach 650 MTU in any year, transfers for cleanup

[7] The 2013 Excess Uranium Inventory Management Plan is available at *http://www.energy.gov/ne/downloads/excess-uranium-inventory-management-plan.*

[8] This figure includes only natural and low-enriched uranium. As of the 2013 Plan, DOE had disposed of the depleted uranium in forms other than UF_6 either through disposal or sale.

[9] The quantity of depleted uranium in this table includes only the UF_6 with an assay above 0.34 wt-% U–235. The corresponding figure from the 2008 plan included UF_6 with an assay above 0.35 wt-% U–235.

services may exceed 600 MTU in the fourth quarter of that same calendar year so long as the total amount does not exceed 2,705 MTU.

D. Transfers Considered in This Determination

This section provides an overview of the various uranium transactions considered in this analysis. The first category of transfers are those that DOE plans to undertake during the next two years pursuant to today's determination under section 3112(d). The second category includes other transfers that have been made or may be made that may be relevant to DOE's analysis of the possible impacts of transfers in the first category. The third category includes the Russian HEU Agreement and Suspension Agreement. This last category of transactions does not directly involve DOE, but section 3112(d) of the USEC Privatization Act instructs DOE to take account of them.

1. Planned Transfers That are Covered by Today's Determination Under Section 3112(d)

Today's determination concludes that certain transfers will not cause adverse material impacts on the domestic uranium industries. Those transfers, outlined below, include transfers of natural uranium for cleanup services at the Portsmouth Gaseous Diffusion Plant and of LEU for down-blending services.

a. Portsmouth Cleanup

Through its Office of Environmental Management (EM), DOE contracts with Fluor B&W Portsmouth for cleanup services at the Portsmouth Gaseous Diffusion Plant. This work involves decontamination and decommissioning of approximately 415 facilities (including buildings, utilities, systems, ponds, and infrastructure units) that make up the former uranium enrichment facility. In recent years, work under this contract has been funded through both appropriated dollars and uranium transfers. As the value of transferred uranium changes depending on market prices and on the Department's decisions regarding how much uranium to transfer, uranium can constitute a greater or lesser proportion of the total funding.

During the period covered by today's determination, DOE plans to transfer up to 1,600 MTU per calendar year of natural uranium hexafluoride in exchange for cleanup services at the Portsmouth Gaseous Diffusion Plant. Today's determination will be issued in the middle of calendar year 2015, after DOE has transferred material for part of the year at the higher rates permitted by the 2014 Determination. However, performing the analysis and determination on a calendar-year basis will just mean that DOE's analysis reflects a higher overall rate for 2015, in light of the material already transferred. Accordingly, for the sake of simplicity, DOE will analyze 2015 transfers for the cleanup program of up to 2,000 MTU.

b. Down-Blending of HEU

NNSA contracts with WesDyne International for down-blending of HEU to LEU. The HEU is transferred to WesDyne's contractor, Nuclear Fuel Services, Inc., in many forms—including metal, oxide, and compounds—and the resulting LEU is in the form of aqueous uranyl nitrate. This program is part of the United States' efforts to eliminate more than 200 metric tons of excess HEU, which is a material that is costly to store securely and represents a proliferation risk. To complete down-blending, the contractor buys natural uranium and uses it to dilute the U–235 contained in the HEU, producing LEU enriched to 4.95 wt-% U–235.

Work under these contracts continues to be funded through the transfer of some of the LEU that results from the down-blending. Under the terms of the contract with WesDyne, DOE can use a mix of money and uranium—ranging from entirely money to entirely uranium—to fund this contract, but in practice funding has been entirely through uranium transfers and is expected to continue to be entirely through uranium unless circumstances necessitate the use of appropriated money.

During the period covered by today's determination, DOE plans to transfer an amount of low-enriched uranium equivalent to up to 500 MTU of natural uranium. This amount is derived by transferring up to 60 MTU per calendar year of low-enriched uranium at 4.95 wt-% U–235 in the form of aqueous uranyl nitrate for down-blending services. Assuming a tails assay of 0.20 wt-% U–235, it would require approximately 555 MTU of natural uranium and approximately 520,000 separative work units (''SWU'') to produce that quantity of LEU. In order to down-blend the HEU to LEU, the down-blending contractor must purchase natural uranium hexafluoride for use as diluent in an amount equal to about 10% of the natural uranium equivalent contained in the LEU, *i.e.* 55 MTU. Thus, DOE considers the natural uranium equivalent of this amount of LEU to be 500 MTU.

As with the transfers for cleanup services at the Portsmouth Gaseous Diffusion Plant, DOE has already transferred some amount of LEU during 2015 at rates permitted by the 2014 determination. For the sake of clarity and for simplicity, and for reasons like those discussed above, today's determination and this analysis cover an amount of low-enriched uranium equivalent to up to 500 MTU of natural uranium for 2015.

2. Other Uranium Transfers by DOE

In addition to transfers described above, this analysis considers several transfers that are not covered by today's determination, for various reasons. Although some of these transfers are not subject to section 3112(d), the Department has analyzed their potential impacts on domestic industries, for those transfers already concluded, and will analyze such impacts for those yet to be carried out, to provide a complete picture of the Department's uranium transfers. In addition, in 2009, DOE issued a Finding of No Significant Impact (''FONSI'') in connection with its National Environmental Policy Act review of its proposed action to sell or disposition excess depleted, natural, and low-enriched uranium. In the Mitigation Action Plan included as part of the 2009 FONSI, DOE undertook to ''conduct an analysis prior to particular sales or transfers . . . to ensure there would be no potentially significant impacts to the domestic uranium industry.'' As part of its Mitigation Action Plan, the Department committed to conducting a market impact analysis of depleted uranium sales or transfers to determine whether such sales or transfers would cause potentially significant impacts on the domestic uranium industries, and to adjust the proposed sales or transfers ''as necessary to ensure that such potentially significant impacts are avoided or mitigated.'' 74 FR 31420, at 31421–22 (July 1, 2009).

In addition, this analysis considers some transfers that may be subject to section 3112(d) but that are still only being planned. While today's determination does not cover those transfers because they are not yet close enough to fruition, DOE conducts this analysis with awareness that these other transfers may happen in years to come.

a. Blended Low-Enriched Uranium to Tennessee Valley Authority

DOE has a significant quantity of HEU inventory that contains various contaminants, so that the down-blended LEU product would not meet American Society for Testing and Materials commercial nuclear fuel specifications. Under a 2001 Interagency Agreement

between DOE and the Tennessee Valley Authority (TVA), DOE provides such ''off-spec'' blended low-enriched uranium (BLEU) to TVA, which uses it in its Brown's Ferry Nuclear Plant. Through 2012, NNSA had down-blended and transferred to TVA an amount of LEU derived from 46 MTU of HEU. In July 2013, NNSA and TVA modified the Interagency Agreement to add a small amount of additional down-blended material.

b. Depleted Uranium Hexafluoride to Energy Northwest

In 2012 and 2013, DOE transferred 9,075 MTU of high assay depleted uranium hexafluoride (DUF_6) to Energy Northwest. Energy Northwest then contracted with USEC, Inc.—now known as Centrus Energy Corp.—to enrich the tails to LEU. Energy Northwest sold most of the resulting LEU to TVA, for use in its reactors between 2015 and 2022. Energy Northwest retained the remaining LEU for use in its own reactors. DOE accepted title to 8,582 MTU of secondary tails resulting from the enrichment of the high-assay tails.

c. Depleted Uranium Hexafluoride to Global Laser Enrichment

In July 2013, DOE issued a Request for Offers for the sale of depleted and off-specification uranium hexafluoride inventories. These inventories include large amounts of high-assay and low-assay depleted UF_6 (DUF_6). In total, the material includes approximately 538 thousand MTU of DUF_6 contained in over 65,000 cylinders currently stored at DOE's Paducah and Portsmouth sites. Under the terms of the Request for Offers, transfers of DUF_6 would begin in calendar year 2019 and would not exceed 2,000 metric tons natural uranium equivalent each year.[10] In November 2013, DOE announced that it was entering into negotiations with GE-Hitachi Global Laser Enrichment, LLC (GLE) for the sale of this material. GLE proposed to license, construct, and operate a new laser enrichment facility in Paducah, KY, to re-enrich the depleted tails.

d. Off-Specification Uranium

The July 2013 Request for Offers also sought offers for the sale of certain amounts of uranium hexafluoride that, like the LEU provided to TVA mentioned above, do not meet American Society for Testing and Materials specifications. This ''off-spec'' material consists of approximately 1,106 MTU contained in 239 cylinders at the Paducah and Portsmouth Gaseous Diffusion Plants. In November 2013, DOE announced that it would enter into negotiations with AREVA for the sale of this inventory.

In 2008, a DOE contractor issued a Request for Proposals for the sale and disposition of off-specification, non-UF_6 uranium located at the Portsmouth Gaseous Diffusion Plant. This inventory consists of approximately 4,461 MTU of uranium in various forms, including metal, oxides, fluorides, and aqueous solutions.

e. Uranium Transfers for Research Applications

DOE also transfers LEU enriched to assays between 5 and 20 wt-% U–235 for domestic and foreign research applications. Most of these transfers are conducted in accordance with section 3112(e) of the USEC Privatization Act, such as transfers to domestic and foreign research reactors; however, some may fall within section 3112(d), such as transfers for use in commercial research and isotope production applications. In general, these transfers do not contribute to any impacts that DOE uranium transfers overall have on domestic uranium industries, because the transfers do not displace commercially supplied uranium, conversion, or enrichment from the market. No commercial supplier is currently capable of providing LEU at these assays, so a research reactor operator would not be able to replace DOE-sourced material by buying uranium hexafluoride and having it enriched to those levels. In general, it would also be technologically infeasible for research reactor operators to replace DOE-sourced high-assay LEU by converting the reactors to use commercial-assay LEU and retain the ability of the reactor to be used for research. Even if these reactors could use LEU (either at high or low assay) from commercial suppliers, the amounts are extremely small. Thus, DOE's supply of high-assay LEU for research applications has at most a *de minimis* effect on the commercial uranium markets, and this analysis therefore does not consider these transfers further.

3. Transactions Under Russian HEU Agreement and Suspension Agreement

As explained below, section 3112(d) of the USEC Privatization Act states that a Secretarial Determination must take into account the sales of uranium under two agreements relating to uranium from the Russian Federation: The Agreement Between the Government of the United States of America and the Government of the Russian Federation Concerning the Disposition of Highly Enriched Uranium Extracted from Nuclear Weapons, Feb. 18, 1993 (''Russian HEU Agreement''), and the Agreement Suspending the Antidumping Investigation on Uranium from the Russian Federation, 57 FR 49220, at 49235 (Oct. 30, 1992) (''Suspension Agreement'').

a. Russian HEU Agreement

The Russian HEU Agreement was originally signed on February 18, 1993, and provided for the purchase over a 20-year period of LEU derived from 500 MTU of weapons-origin HEU from Russia. In total, this material contained the equivalent of almost 400 million pounds U_3O_8, 150 million kilograms of uranium (kgU) of conversion services, and approximately 92 million SWU of enrichment services.

The sale of this uranium into the commercial market has not directly involved DOE. The material was actually transferred to the United States through a commercial agreement between the U.S. and Russian Executive Agents. The U.S. Executive Agent—initially the United States Enrichment Corporation, and later the private corporation USEC, Inc.—then sold the LEU into the U.S. nuclear fuel market to commercial utilities.

The USEC Privatization Act altered the implementation of the Russian HEU Agreement. The Act directed the Executive Agent to enter into an agreement to return to the Russian Executive Agent an amount of uranium equivalent to the natural uranium component of LEU received under the agreement after January 1, 1997, or, if the Russian Executive Agent did not enter such an agreement, to auction the uranium.[11] The Act also placed annual limits on the delivery to U.S. utilities of the uranium thus provided to the Russian Executive Agent. Specifically, the Act limited deliveries to no more than 2 million pounds U_3O_8 equivalent in 1998. The limit increased annually, finally reaching 20 million pounds U_3O_8 equivalent in 2009 and each year thereafter. 42 U.S.C. 2297h–10(b)(5). The USEC Privatization Act did not place any limit on the delivery of the conversion component of uranium

[10] Note that the amount of ''natural uranium equivalent'' contained in a given amount of depleted uranium depends on the assay of the depleted uranium. These terms are discussed more fully below.

[11] Under this arrangement, USEC received LEU from Russia, sold the enrichment component, and then returned the natural uranium component in the form of natural uranium hexafluoride to the Russian Executive Agent. The Russian Executive Agent entered into a separate agreement with a consortium of western uranium producers to sell the natural uranium and conversion.

returned to the Russian Executive Agent or auctioned in the absence of a return agreement. 42 U.S.C. 2297h–10(b)(8). The last deliveries under the Russian HEU Agreement took place in 2013.

b. Suspension Agreement

In 1991, the Department of Commerce initiated an antidumping duty investigation under the Tariff and Trade Act to determine whether imports of uranium from the U.S.S.R. were being sold into the United States at less than fair value. In 1992, the Department of Commerce entered into an agreement with the Russian Federation (''Suspension Agreement'') suspending the antidumping investigation and establishing export limits on uranium from those countries. 57 FR 49220 (Oct. 30, 1992).

The Suspension Agreement has been amended several times since it first came into force. At the time the USEC Privatization Act was passed in 1996, the Suspension Agreement allowed Russian natural uranium and SWU to be imported only if it was matched with an equal portion of newly-produced U.S.-origin natural uranium or SWU. These ''matched sales'' were subject to annual volume limits ranging from 1.9 million to 6.6 million pounds U_3O_8 equivalent between 1994 and 2003. 59 FR 15373, at 15374 (Apr. 1, 1994). The USEC Privatization Act specifically stated that sales of the natural uranium component of HEU under the Russian HEU Agreement were excluded from the Suspension Agreement limits. 42 U.S.C. 2297h–10(b)(6).

The most recent iteration of the Suspension Agreement entered into force in 2008. 73 FR 7705 (Feb. 11, 2008). That agreement provides for the resumption of sales of natural uranium and SWU beginning in 2011. While the HEU Agreement remained active (*i.e.* 2011–2013), the annual export limits were relatively small—between 0.4 and 1.1 million pounds U_3O_8 equivalent. After the end of the Russian HEU Agreement, restrictions range between 11.9 and 13.4 million pounds U_3O_8 equivalent per year between 2014 and 2020. 73 FR 7705, at 7706 (Feb. 11, 2008).

II. Overview of Uranium Markets

The nuclear fuel market consists of four separate industries: mining/milling, conversion, enrichment, and fabrication. These industries interact in complicated and sometimes counterintuitive ways. In order to analyze the effect on the various industries of introducing a given amount of uranium into the market, it is necessary to understand how uranium is processed into nuclear fuel, how the different aspects of this process interact, and how the consumers of uranium—nuclear reactor owners/operators—procure uranium. This section provides an overview of these industries and markets, beginning with the process for producing nuclear fuel from uranium ore.

A. The Nuclear Fuel Cycle

In order to be useful as fuel for a reactor, uranium must be in a specific chemical form, it must have the correct isotopic concentration, and it must be fabricated into the correct physical shape and orientation. The four nuclear fuel cycle industries—mining, conversion, enrichment, and fabrication—ensure that reactor operators have a steady supply of usable fissile material to fuel their reactors.

1. Mining

The first step in the nuclear fuel cycle is mining. Uranium is relatively common throughout the world and is found in most rocks and soils at varying concentrations. There are two primary methods of mining uranium: Conventional and in-situ recovery. Which method is used for a particular deposit depends on the specific characteristics of the deposit and surrounding rock.

Conventional mining can involve either open pit or underground removal of uranium ore. Once removed from the ground, the uranium ore must be transported to a mill for processing. Many mining operations are located close to mills; where mines are close together, one mill may process ore from several different mines. Once at the mill, the ore is crushed and chemically treated to remove the uranium from the other minerals, a process called ''leaching.'' The solids are then separated from the solution and dried. The final result is a powdered uranium oxide concentrate, often known as ''yellowcake'' and predominately made of triuranium octoxide, or U_3O_8. This powdered yellowcake can be packed in drums and shipped for the next stage of processing.

An alternative mining process is known as in-situ recovery (ISR). In ISR mining, the uranium ore is not removed from the ground as a solid. Instead, an aqueous solution—either acid or alkali—is pumped into the ground through injection wells, through a porous ore deposit, and back out through production wells. As the solution moves through the ore deposit, the uranium in the ore dissolves or leaches into the solution. Once the uranium-laden solution is pumped out, it is pumped to a treatment plant where uranium is recovered and dried into yellowcake. In order to maintain a stable rate of production, wellfields must be continually developed and placed into production.

There are several key differences between conventional and ISR mines. ISR mining typically has lower costs, both capital and operational. ISR mines also have a shorter lead-time for development. There are other advantages compared to conventional mining such as decreased radiation exposure for workers, reduced surface disturbance, and reduced solid waste. However, ISR mining can only extract uranium located in deposits that are permeable to the liquid solution used to recover the uranium, and the permeable deposit must have an impermeable layer above and below to prevent the solution from leaching into groundwater. To the extent that uranium is located in other types of deposit ISR mining may not be possible.

2. Conversion

The second step in the nuclear fuel cycle is conversion. When yellowcake arrives at conversion facilities it may contain various impurities. The conversion process refines the uranium compounds and prepares it for the next stage.

As discussed in the next section, most nuclear reactors require uranium that is enriched in the isotope U–235.[12] The enrichment process typically requires uranium to be in a gaseous form. To meet this need, U_3O_8 is converted into uranium hexafluoride (UF_6), which sublimes—*i.e.* converts directly from solid to gas—at a temperature (at normal atmospheric pressure) of approximately 134 °F (56.5 °C). The UF_6 is then loaded into large cylinders and shipped to an enrichment facility.

There are several different processes for converting U_3O_8 to UF_6. The two most significant processes are known as the ''wet process'' and ''dry process.'' Both processes have three essential steps: Reduction, hydrofluorination, and fluorination. These steps do not differ substantially between the two processes. The main difference between the wet process and dry process is in how they remove impurities. In the wet process, used in facilities in France and Canada, yellowcake is treated with nitric acid, concentrated, and dried into UO_3 powder prior to reduction.[13] In the dry

[12] Some nuclear reactors, particularly pressurized heavy water reactors, use natural uranium.

[13] Port Hope, Ontario, Canada, and COMURHEX Malvési/Pierrelatte, France, use the wet process. *See* AREVA, ''Chemical Operations Around the World,'' *http://www.areva.com/EN/operations-687/*

Continued

process, used at the Metropolis Works facility in Illinois, purification takes place at the very end of the process through distillation of UF_6.[14]

3. Enrichment

The third step in the nuclear fuel cycle is enrichment. As found in nature, uranium consists of a mixture of different uranium isotopes. The two most significant isotopes are U–235 and U–238. The relative concentration of the various isotopes of uranium in a given amount is referred to as the isotopic concentration or ''assay.'' [15] Uranium as found in nature consists of approximately 0.711% U–235, 99.283% U–238, and trace amounts of U–234. Uranium that exhibits the naturally occurring isotopic concentration is called ''natural uranium.''

Nuclear reactors typically require uranium that is enriched in the isotope U–235, meaning that it has a higher concentration of U–235 compared to natural uranium. Commercial light water reactors, which are the most common type of nuclear reactor, typically require an assay of 3% to 5% U–235. Uranium enriched in the isotope U–235 is referred to as low-enriched uranium (LEU) if the assay is less than 20% but above 0.711%, and highly-enriched uranium (HEU) if the assay is greater than 20%.

There are many different enrichment processes, but only two have been used commercially: Gaseous diffusion and gas centrifugation. These technologies exploit the mass difference between U–238 and U–235 atoms. In a centrifuge, centripetal acceleration tends to concentrate lighter materials towards the center of the rotation and heavier materials towards the outside of the rotating vessel. The mass difference between a UF_6 molecule with U–238 and one with U–235 is slight, so even at high rotation speeds the concentration changes are small. To achieve a concentration increase from 0.711% to 5%, a facility passes material through many stages of centrifugation. Currently, all commercial enrichment services use gas centrifuge technology; the last commercial-scale gaseous diffusion facility ceased operating in 2013.

After UF_6 arrives from a conversion facility, it can be introduced into the enrichment centrifuges. Material introduced in this manner is referred to as ''feed.'' The centrifuges then separate the isotopes into varying levels of enrichment and produce two streams of material: Product and tails. The product is the enriched UF_6 output. This LEU is then pumped into a 2.5 ton cylinder and shipped to a fabrication facility. Just as the product stream has a higher proportion of U–235 to U–238 than the original feed, the other stream, the tails, has a lower proportion of U–235 to U–238. This material is referred to as ''depleted.'' It is pumped into large (typically 10 or 14 ton) cylinders and then stored on site at the enrichment facility for eventual disposal or other use. The assay of U–235 in the tails from an enrichment process depends on what concentration of U–235 was needed in the enriched product and how much natural uranium was used as feed. Typical tails assays range from 0.1% to 0.4%.

4. Fabrication

The final step in the process is fabrication. Almost all nuclear reactors require fuel to be in the form of uranium dioxide (UO_2). At the fabrication facility, the enriched UF_6 is converted into UO_2 powder, and then formed into small ceramic pellets. These pellets are then loaded into metal tubes and attached together to form fuel assemblies. Fuel design is reactor specific, and thus each fuel assembly is manufactured to the unique specifications of the reactor operator. Although fabrication is an important step in the fuel cycle, this analysis does not cover effects in the fabrication market.

5. Secondary Supply

Uranium that undergoes the above-described four steps without any intermediate use is generally termed ''primary supply.'' However, there are other sources of uranium available in the market. Uranium from these other sources is collectively known as ''secondary supply.'' In addition to government inventories of uranium left over from other uses such as weapons production, the most significant secondary supplies come from excess enrichment capacity.

Due to technical constraints, enrichers generally cannot easily decrease capacity that is already constructed and operating. If an enricher were to shut down a centrifuge that is currently spinning, it may not be possible to restart the centrifuge. Due to this possibility, decreasing capacity risks damaging the machines and destroying the substantial capital investment in construction. As a result, enrichers that have unsold capacity will tend to apply the excess enrichment work in one of two ways.

First, enrichers can apply extra separative work to a given amount of feed material, thus extracting more of the U–235. This is known as ''underfeeding'' because it enables the production of a given amount of enriched product with a smaller amount of feed material. Normally, a purchaser of enrichment services seeking a specific amount of enriched product would need to determine (1) how much natural uranium feed to provide and (2) how much SWU to apply to it. Increasing the amount of enrichment services has a cost, but the additional work will extract more of the U–235 content of the feed material so that less is needed, at less cost. The relationship between the prices of uranium concentrates, conversion, and enrichment can be used to determine the amount of feed and SWU—and thus also the resulting tails assay—that will lead to the lowest cost per kilogram of enriched product. This is known as the ''optimal tails assay.'' If an enricher knows that it has excess capacity, it may choose to feed in a smaller amount of natural uranium and apply more SWU to that material than was purchased. Thus, the end result is the desired amount of enriched product, depleted tails, and the natural uranium that was delivered to the enricher but was not fed into the enrichment process. The enricher can then sell this natural uranium on the open market.

Second, enrichers can feed depleted tails back into the enrichment process and apply additional separative work to them. This is known as re-enrichment of tails. As described above, the optimum tails assay varies over time as the prices of uranium concentrates, conversion, and enrichment change relative to each other. Over time, depleted tails with relatively high assays may accumulate. An enricher may choose to select the highest-assay tails and feed them back into the enrichment process. These tails can be enriched up to the level of natural uranium (0.711%) or higher. The enricher may then sell the resulting natural uranium or LEU on the open market.

An additional source of secondary supply is from recycled uranium and plutonium either from reprocessing of commercial spent fuel or from weapons-

chemistry-business-unit-sites-around-the-world.html (accessed Mar. 31, 2015); Cameco, ''Port Hope Conversion,'' *http://www.cameco.com/fuel_services/port_hope_conversion/* (accessed Mar. 31, 2015).

[14] Details on the dry process are described at: ConverDyn, ''Honeywell Dry Fluoride Volatility Conversion Process,'' *http://www.converdyn.com/product/conversion.html* (accessed Mar. 31, 2015). Although the three most significant western converters use either the wet or dry process, conversion plants in Russia use a slightly different process called the ''direct fluorination'' method. This method is described in UxC Conversion Market Outlook—December 2014, 8–9 (2014).

[15] The measure of assay is sometimes referred to in terms of ''weight-percent'' or ''wt-%.''

grade plutonium disposition. The product of these processes enters the fuel cycle and is fabricated into mixed oxide (MOX) fuel. MOX fuel is currently in use in Europe and Japan. Two commercial facilities currently produce MOX fuel in France and in the United Kingdom. Other facilities, such as the J–MOX project in Japan, are either planned or under construction.

6. Note on Units

As discussed above, the different uranium industries use slightly different units. Uranium concentrates are generally measured in pounds U_3O_8, conversion services are generally measured in kgU as UF_6, and enrichment services are measured in SWU.

It is worth noting that the measures of uranium concentrates and conversion services are not identical for several reasons. In addition to the fact that one is denominated according to U.S. customary units and the other is denominated under the international system of units (SI), the measure of uranium concentrates refers to the mass of U_3O_8 whereas the conversion metric refers only to the mass of the uranium atoms. Only about 85% of the mass of U_3O_8 consists of uranium. Thus, one kilogram of U_3O_8 contains approximately 0.848 kgU. Furthermore, converting between pounds U_3O_8 and kgU as UF_6 must take into account an estimated 0.5% loss during the conversion process. Taking all this into account, one pound U_3O_8 is equivalent to 0.383 kgU as UF_6, and one kgU as UF_6 is equivalent to 2.61 pounds U_3O_8.

Converting between uranium concentrates or conversion services and enrichment is more difficult because the amount of SWU necessary to produce a given amount of product depends on the desired product assay, the feed assay, and the tails assay. An example will serve to illustrate the significance of different assumptions. Assuming a tails assay of 0.30%, enriching 1,000 kgU as UF_6 of natural uranium to an assay of 4.50% would require approximately 609.7 SWU and would yield 97.9 kgU of enriched uranium; if a tails assay of 0.20% is used instead, enrichment would require approximately 913.9 SWU and would yield 118.8 kgU of enriched uranium.

DOE typically describes its uranium inventory in terms of MTU for natural uranium and MTU ''natural uranium equivalent'' for depleted and enriched uranium. These terms have a slightly different meaning depending on the form. For natural UF_6—*i.e.* with an assay of 0.711%—1 MTU would represent 2,610 pounds U_3O_8, 1,000 kgU as UF_6 of conversion services, and 0 SWU. For enriched or depleted UF_6, the amount of natural uranium equivalent depends on the assay. For depleted UF_6, DOE calculates natural uranium equivalent as the amount of natural uranium product that could be produced by re-enriching the depleted material. For the purposes of this analysis, DOE assumes the enrichment process would use a tails assay of 0.20%. As an example, 1,000 MTU of DUF_6 with an average assay of 0.40% would yield approximately 350 MTU natural uranium equivalent. For LEU, DOE calculates natural uranium equivalent as the amount of natural uranium that would be needed as feed material to produce the LEU, given the assay of the LEU and assuming a tails assay of 0.20% and a feed assay of 0.711%. For LEU resulting from down-blending of HEU, DOE then subtracts out the amount of natural uranium feed—''diluent''—that is necessary to down-blend the HEU to the desired product assay. The amount of diluent required is typically equivalent to approximately 10% of the natural uranium that would be needed as feed for enrichment. This subtraction is appropriate for purposes of section 3112(d) analysis to indicate how much natural uranium a given amount of LEU would displace from the market. Because DOE's contractor procures diluent on the market (rather than from DOE inventory) in order to produce the transferred LEU, the transfer displaces that much less commercially supplied natural uranium.

B. The Uranium Markets

1. The Uranium Markets Are Separate

Uranium concentrates, conversion services, and enrichment services can be traded separately. Prices for uranium concentrates are typically quoted in terms of dollars per pound U_3O_8. Prices for conversion services are typically quoted in terms of dollars per kilogram uranium (kgU). Prices for enrichment services are typically quoted in terms of dollars per SWU.

A typical transaction may involve a single purchaser purchasing a given amount of uranium concentrate through a contract directly with the mining company. The uranium concentrate is typically delivered directly to a conversion facility rather than to the purchaser. The purchaser will also enter into a separate contract for conversion services. The terms of this contract will require the purchaser to deliver U_3O_8 to the converter, and the converter will provide UF_6 in return. The UF_6 will then be shipped directly to an enricher. As with conversion, the purchaser will enter into a separate contract for SWU from an enricher. Contracts terms vary, but this contract will likely require the purchaser to deliver a specific amount of natural UF_6 feed and the enricher to deliver a specific amount of UF_6 enriched to the desired assay. This LEU will typically be delivered directly to the fabricator to be made into nuclear fuel.

Although there are separate markets for each step in the process, the different steps are sometimes combined. It is possible to buy natural UF_6, which would reflect both the uranium concentrate and the conversion services. Similarly, it is possible to buy enriched UF_6—usually known as enriched uranium product (EUP)—which would reflect all three steps. The price for these products is typically developed by adding the cost of the various steps together. Thus, the price of EUP would be based on the price of an equivalent amount of uranium concentrates, conversion, and enrichment. In practice, however, the price of a product material, like EUP or natural UF6, may occasionally differ somewhat from the sum of the input prices. Because most volume is transacted in long-term contracts, a small price gap may not be eliminated quickly by arbitrage. In addition, the price of a product material reflects transaction and shipping costs needed to move material through the various steps.

In addition, even though the three components are traded separately, there is some interrelationship between the prices. Since optimal tails assay is a function of the relative price of uranium concentrates, conversion, and SWU, changes in one price can lead to shifts in demand and supply in the other markets. Similarly, excess enrichment capacity used for underfeeding or re-enrichment of tails increases supply of uranium concentrates and conversion services. Thus, changes in enrichment supply may contribute to changes in uranium concentrate and conversion prices.

2. Uranium Is Fungible

Although the above represents a typical series of uranium transactions, there are many other potential types of transactions. These other forms are possible because uranium at each stage of the fuel cycle is fungible. As long as the basic characteristics like form and assay are the same, one kilogram of material is essentially the same as any

other.[16] Accounting mechanisms allow the ownership of each kilogram of material to be traceable, and they also allow ownership to be exchanged freely without physically manipulating the material.

A simple example illustrates the types of transaction that this fungibility enables. After U_3O_8 is converted into UF_6, it will typically be shipped to a specific enrichment facility. If the uranium was mined and converted in North America, it will typically be sent to an enricher in North America. However, the purchaser is not necessarily required to purchase enrichment services from the company whose facility the material is shipped to. Instead, the purchaser may be able to exchange ownership of an amount of UF_6 located at a North American enrichment facility with an equivalent amount located at a facility in Europe. This is referred to as a ''book transfer.''

An entity can also sell conversion services or enrichment services without actually physically converting or enriching any material. A person that owns enriched UF_6 may enter into a contract to sell SWU whereby it provides the desired amount of enriched UF_6 in exchange for the cost of the SWU and a specific amount of natural UF_6 ''feed.'' A person can also use natural UF_6 to sell conversion services by exchanging it for the cost of the conversion services plus the equivalent amount of U_3O_8.

3. The Uranium Markets Are Global

All three markets are global in nature. Purchasers are able to buy from suppliers worldwide and vice versa. Pricing for uranium concentrates and enrichment are essentially the same worldwide. Shipping costs are relatively low compared to other components of the prices, and the fungibility of the material allows suppliers and purchasers to minimize shipping costs through book transfers.

Although conversion services also trade on a worldwide market, in recent years there has been a persistent difference between prices in North America and those in Europe. DOE believes this stems from a geographical imbalance in conversion capacity relative to enrichment capacity. There is more conversion capacity in North America than enrichment capacity, and conversely in Europe there is more enrichment than conversion capacity. Consequently, there is a regular net flow of conversion services from North America to Europe. Meanwhile, it seems likely that the cost of shipping is larger relative to the conversion price than it is relative to the price of uranium or enrichment—mainly because conversion is the least costly input among the three, roughly $7.50 per kilogram at current spot prices compared to just over $100 per kilogram for uranium in concentrates. DOE believes the price difference between North American conversion and European conversion reflect simply the additional cost of shipping converted material from North America to Europe, together with the fact that net flow is from North America to Europe.

C. The Nature of Demand for Uranium

1. Utility Use of Uranium

The vast majority of uranium in commercial use is fuel for commercial power generation. According to the International Atomic Energy Agency (IAEA), there are 440 commercial reactors operating worldwide, 99 of which are in the United States. *See* IAEA, ''Power Reactor Information System,'' Mar. 2015, *http://www.iaea.org/pris/* (accessed March 24, 2015). The total installed electricity generation capacity of all reactors worldwide is 378,220 MW_e (megawatt electrical), 98,638 MW_e of which is from U.S. reactors. *Id.*

Nuclear reactors typically provide what is known as ''baseload'' electricity supply. This means that nuclear reactors generally operate close to their full practical capacity continuously. Thus, the amount of uranium needed for each reactor in a given year does not generally fluctuate with electricity use patterns. It depends instead on the total capacity of the reactor and the fuel reload schedule. The average reactor capacity worldwide is approximately 860 MW_e, and the average capacity of U.S. reactors is 996 MW_e. *Id.* Reload schedules vary, but reactors typically must reload a portion of the total fuel in the core every 18 to 24 months.

According to the World Nuclear Association (WNA), a typical 1,000 MW_e light water reactor operating today requires approximately 24 MTU of LEU at an assay of 4% each year.[17] At a tails assay of 0.25%, this corresponds to approximately 140,000 SWU of enrichment, 195,000 kgU of conversion services, and 510,000 pounds U_3O_8. *See* WNA, ''The Nuclear Fuel Cycle,'' Oct. 2014, *http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Introduction/Nuclear-Fuel-Cycle-Overview/* (accessed March 24, 2015). Reload amounts and schedules differ depending on reactor size and type. Pressurized heavy water reactors, for example, do not require enrichment at all.

It is also worth noting that nuclear fuel makes up a very small percentage of overall costs for nuclear reactors—typically less than 10%. According to DOE's Energy Information Administration (EIA), for new nuclear generation, variable operations and maintenance costs, which include fuel costs, account for only about 12% of total system levelized costs. *See* EIA, ''Levelized Cost of New Generation Resources in the Annual Energy Outlook 2014,'' Apr. 2014, *http://www.eia.gov/forecasts/aeo/electricity_generation.cfm* (accessed Mar. 24, 2015). Further, the Nuclear Energy Institute reports that nuclear fuel costs make up about 30% of total operating costs. *See* NEI, ''Fuel as a Percentage of Electric Power Production Costs,'' *http://www.nei.org/Knowledge-Center/Nuclear-Statistics/Costs-Fuel,-Operation,-Waste-Disposal-Life-Cycle/Fuel-as-a-Percent-of-Production-Costs* (accessed Mar. 30, 2015).

2. Uranium Requirements

The amount of fuel necessary to keep a reactor operating is relatively predictable. Although there is always the possibility of unplanned outages, reactor operators generally know how much enriched uranium they will need. The amount of uranium needed to fuel operating reactors is generally referred to as ''requirements.'' Small uncertainties in predictions about requirements are possible in the short run because an operator can vary its need for fuel to some degree by changing operating conditions.

For a given reactor operator, this predictability enables the operator to purchase uranium, conversion, and enrichment on long-term contracts. These contracts often have first delivery as much as five years in the future and can extend as long as ten or even fifteen years from the contract date. In addition, because shutting down a reactor for refueling is a complex and carefully orchestrated process that requires extensive planning, a reactor operator generally has strong incentives to ensure well in advance of each refueling that the reactor will be sufficiently supplied with fuel. Long-term contracts help meet that goal by providing a reactor operator guaranteed quantities of supply. Consequently, the vast majority of purchases of uranium concentrates, conversion, and

[16] Other important characteristics include the presence and concentration of contaminants, some of which can render material unusable as nuclear fuel. Industry standards specify the acceptable levels of contamination.

[17] This is an annual average. Since reactors do not necessarily refuel every year, each reactor would actually require somewhat more than 24 MTU every 18–24 months.

enrichment are through term contracts—above 80%. The specific proportions of short-term versus long-term contracts are discussed below in Section II.E.1.

Aggregate requirements are also relatively predictable. However, long-term projections of future requirements must take into account changes in requirements from short-term outages, permanent shutdowns, and new reactor construction. Various entities develop and publish projections of future uranium requirements based on different assumptions about the rates of these changes, as well as different assumptions about operating conditions like reload schedules and fuel utilization (''burnup''), and about the possibility of unplanned outages or other temporary fluctuations in nuclear fuel use. These forecasts typically are based only on the nuclear fuel expected to be used in operating reactors; they do not include purchases of strategic or discretionary inventory.

3. Requirements Versus Demand

Demand for uranium, conversion, or enrichment is generally not the same as reactor requirements in a given year. Some sources of demand are either in excess of or unconnected to reactor requirements. For example, many reactor operators hold strategic inventories of uranium beyond their requirements. This material provides flexibility in the event of a supply disruption. Different operators may have different strategic inventory policies, and those policies will shift over time. Changes in the level of strategic inventories held by individual reactors can produce additional demand or remove demand. Demand from reactor operators purchasing uranium for strategic inventory is commonly referred to as ''discretionary demand.''

There are a number of market participants that are currently building inventory well above the strategic inventory that is typical of other operators. China, for example, has in recent years purchased as much as three times its current annual requirements. Japanese reactors have also been building inventory well in excess of requirements. Many Japanese reactors were shut down following the accident at the Fukushima Daiichi nuclear power plant in March 2011. Even though the reactors are not currently operating, many Japanese operators have continued to receive contracted deliveries of uranium.

In addition to reactor operators purchasing in excess of demand, there are a number of market participants that do not operate reactors at all. These include traders, brokers, and investment funds. These entities may purchase uranium when prices are low and resell it to reactor operators under future delivery contracts or hold uranium inventory until prices increase.

These activities mostly involve only uranium concentrates. However, some purchases in excess of requirements involve natural UF_6 or EUP. Thus, this behavior typically affects demand for uranium concentrates much more than it affects conversion and enrichment demand.

Finally, changes in optimal tails assay can affect demand in a given year. Estimates of future reactor requirements typically assume a specific tails assay for enrichment. However, if enrichment prices change relative to uranium concentrate and conversion prices, some purchasers may have flexibility to specify a different tails assay for enrichment. This changes the amount of uranium concentrates, conversion, and SWU that are necessary to produce a given amount of fuel.

4. Price Elasticity of Demand

Price elasticity of demand is an economic measure that shows how the quantity demanded of a good or service responds to a change in price. If purchasers are highly responsive to changes in price, demand is relatively elastic. If purchasers are weakly responsive to changes in price, demand is relatively inelastic. If purchasers demand the same amount regardless of the price, demand is perfectly inelastic.

In general, demand for uranium, conversion, and enrichment are relatively inelastic. Since requirements are largely fixed, changes in price have a weak effect on demand. However, uranium markets exhibit different degrees of elasticity on different time frames.

a. Short Term

In the short term, DOE expects that demand is more elastic than in the medium and long terms. Some of the behaviors discussed in the previous section are responsive to short term changes in price. Traders and investment funds are more likely to make speculative purchases when prices are low. Similarly, large-scale strategic buying, as China is doing, has corresponded with a period of very low prices. It seems likely that these purchases would decrease if short term uranium prices increased substantially.

These practices may be somewhat counteracted by the behavior of utilities. Although some utilities choose to build inventories when prices are low, others do the opposite. Somewhat counterintuitively, some reactor operators actually purchase less strategic inventory when prices are low. This appears to be related to perceptions about long-term security of supply. When prices are high, it may suggest scarcity in long term supplies. When prices are low, this may signal that long term supplies are relatively secure. Thus, reactor operators may paradoxically purchase more strategic inventory when prices are high.

As mentioned above, these behaviors are much more prevalent in the uranium concentrates markets. Demand in the conversion and enrichment markets may therefore exhibit less elasticity in the short term than the uranium market.

b. Medium and Long Term

DOE expects that demand in the medium and long term is less elastic than in the short term. Indeed, in the medium term, demand for long-term contracts may actually increase, relative to spot purchases, as prices rise. As discussed above, fuel costs represent a very small portion of the overall cost of nuclear power.

Conversely, the cost of not having fuel can be very high, because the economics of nuclear reactors—*i.e.* large up front capital costs and low marginal operating costs—incentivize operators to operate more or less continuously. Compared to the opportunity cost of an extended period where the reactor is not generating electricity, fuel costs are relatively small. Typically, fuel costs are about 1 cent per kilowatt hour generated, while the market value of the electricity is between 5 and 8 cents per kilowatt hour.

An increase in prices generally indicates a tightening of supply relative to demand. That signal can encourage reactor operators to increase, rather than decrease, long-term contracting to ensure future fuel supplies in the face of the anticipated tightening. The additional cost of a high-priced contract may be less important than the avoided risk of not having enough fuel. As a possible example of such behavior, long-term contracting for uranium concentrates increased significantly in 2005 and remained high in 2006 and 2007 as prices rose from approximately $20 per pounds in 2004 to over $90 in 2007; long-term contracting activity then fell in 2008 and 2009 as term prices fell from above $90 to closer to $60.

In the long term, elasticity of demand for nuclear fuel would reflect decisions about whether to construct new reactors or shut down existing reactors in response to long-run prices for fuel. This contribution to elasticity is likely to be small. Because fuel costs are such

a small portion of the overall cost of nuclear power, even a large increase in fuel price would be unlikely to significantly affect decisions about new reactor construction. Meanwhile, for existing reactors the capital costs are ''sunk.'' And ongoing variable fuel costs for nuclear power are, at current prices, lower than for most other types of generation.[18] Thus, among existing plants, it would take a very large increase in the cost of fuel to influence a decision about whether to shut down a reactor early.

As noted above, plans for reactor construction do change over time, so that uranium requirements will evolve over time. Demand for uranium is not constant. However, the changes in long-term demand are unlikely to be responses to uranium price signals. For these reasons, the analysis below will assume that medium- and long-term demand has low elasticity.

D. The Nature of Uranium Supply

1. Primary Versus Secondary Supply

As explained above, supply of uranium concentrates, conversion, and enrichment includes both primary and secondary supply. According to charts developed by uranium market consultancy ERI, total production of uranium concentrates in 2015 and 2016 will be approximately 190 million pounds U_3O_8. 2015 ERI Report, 9.[19] Secondary supply is expected to total approximately 40 million pounds, about 20% of the total. Over half of secondary supplies of uranium concentrates come from enricher underfeeding and tails re-enrichment. Other sources of secondary supply include DOE inventory, plutonium/uranium recycle (MOX), and other commercial inventories. 2015 ERI Report, 80. Prior to 2014, the natural uranium component of LEU delivered under the Russian HEU Agreement represented a significant source of secondary supply. This program ended in 2013. Consequently, natural uranium from Russian HEU is no longer a significant source of secondary supply.

For conversion services, ERI expects that primary supply in 2015 and 2016 will total approximately 65 million kgU as UF_6, with secondary supply representing between 15 and 16 million kgU or about 25%. 2015 ERI Report, 14. As with uranium concentrates, over half of secondary supplies of conversion come from enricher underfeeding and tails re-enrichment. Other sources of secondary supply include DOE inventory, plutonium/uranium recycle (MOX), and other commercial inventories. *Id.*

For enrichment services, ERI expects that primary supply in 2015 and 2016 will total approximately 63 million SWU, with secondary supply representing between 4 and 5 million SWU or about 8%. 2015 ERI Report, 16. Unlike uranium concentrates and conversion services, underfeeding and tails re-enrichment do not constitute a secondary supply of enrichment because those processes utilize enrichment capacity. Sources of secondary supply of enrichment include DOE inventory, plutonium/uranium recycle (MOX), and other commercial inventories. *Id.*

2. Price Elasticity of Supply

Price elasticity of supply measures how the quantity supplied of a good or service responds to a change in price. If suppliers are highly responsive to changes in price, supply is relatively elastic. If suppliers are weakly responsive to changes in price, supply is relatively inelastic.

Enrichment services are relatively inelastic, and conversion services are complicated by pricing phenomena described below. With respect to uranium concentrates, the level of elasticity in the uranium markets varies depending on the time frame, just as demand elasticity does.

a. Short Term

In the short term, supplies of uranium concentrates from primary producers are relatively inelastic. There is some limited capability for mines to decrease production. Conventional mines may choose to continue operation and stockpile uranium ore without milling it into yellowcake. ISR mines require constant development of new wellfields; these mines may slow production gradually by slowing wellfield development. These measures may take many months. Thus, in the short term, mines will be weakly responsive to changes in price. In contrast, secondary sources of uranium concentrates may respond more to changes in price. Underfeeding and tails re-enrichment, for example, depend on the relationship between SWU and uranium concentrate prices. In the short-term, enrichers cannot increase or decrease capacity, but they can quickly shift how much capacity is devoted to underfeeding versus primary enrichment.

Primary supply of conversion services is relatively inelastic in the short term. Conversion plants typically have high fixed production costs. Thus, there is relatively little incentive to change production in response to changes in price. (As discussed below, conversion supply has fluctuated in recent years; but those changes were not necessarily caused by price changes.) Secondary supplies of conversion, however, are more able to respond to changes in price. Underfeeding and tails re-enrichment results in natural UF_6, which includes both uranium concentrates and conversion services. Since the price of uranium concentrates is a larger proportion of the value of that UF_6, secondary supplies of conversion from these two sources can be expected to respond more strongly to the uranium concentrates price than to the conversion price.

Primary supply of enrichment is also relatively inelastic in the short term. As discussed above, enrichers typically cannot remove machines from production due to technical concerns. Enrichers also cannot bring additional machines online in the short term to respond to changes in price because it takes several years to add new machines. Secondary supply of enrichment is a smaller proportion of the total supply than for uranium concentrates or conversion services. In addition, enrichers can change the amount of capacity devoted to primary enrichment as opposed to underfeeding. These supplies are more able to respond to changes in price.

b. Medium and Long Term

In the medium and long term, primary supplies of uranium concentrates and enrichment should be more elastic than in the short term. Producers can develop and install additional capacity in response to projections that prices will increase. These decisions, however, typically involve very long time frames. It may take several years of active development before a new mine may begin production. New enrichment and conversion capacity may take on the order of ten years.[20] Alternatively,

[18] Variable costs are higher for fossil fuel technologies by a factor of 4 for natural gas, and by a factor of almost 3 for conventional coal. The only technologies with lower variable costs are geothermal, wind, solar, and hydro. *Id.*

[19] DOE tasked ERI to assess the potential effects on the domestic uranium mining, conversion, and enrichment industries of the introduction into the market of DOE excess uranium inventory. ERI's analysis of these effects is contained in the 2015 ERI Report. ERI's analysis is based in part on information it collects to develop its forecasts for annual reactor requirements, uranium demand, and uranium production. ERI develops these forecasts for various customers. The references to information from ERI in Section II are generally based on this type of information rather than on ERI's economic analysis of these data specifically for DOE. Because of ERI's expertise in the uranium markets and contacts with market participants, DOE believes ERI's general market information is reliable.

[20] Louisiana Energy Services, LLC, now a subsidiary of URENCO, submitted a license

producers can reduce production and accelerate plans to retire capacity if prices are projected to decrease. URENCO, for example, has chosen to retire enrichment capacity at its European facility without replacement. *See* 2015 ERI Report, 16.

E. Uranium Prices

Uranium markets function in two ways, broadly speaking: Short-term deliveries, called the spot market, and longer-term commitments, called the term market.

1. Spot and Term Prices

For all three markets discussed here, there is a price for an immediate delivery, called the spot price, and a price for long-term contractual commitments, commonly called the term price. The vast majority of purchases on these markets are through term contracts. According to data from EIA, over 80% of purchases of uranium by U.S. owners and operators of nuclear power reactors in 2013 were through term contracts.[21] EIA, 2013 Uranium Marketing Report, 3 (2014). In addition approximately 97% of enrichment services purchased by U.S. owners and operators in 2013 were through term contracts. *Id.* at 46. EIA does not report data on conversion contracts. Ux Consulting Company, LLC (UxC), a private consulting firm, publishes data on spot and term contract volume for conversion services. According to UxC, deliveries in 2013 under term contracts—[REDACTED]. UxC Conversion Market Outlook—December 2014, 36 (2014). In contrast, spot contract volume in 2013 [REDACTED]. *Id.* at 26. Thus, term contract deliveries represented [REDACTED] of 2013 deliveries of conversion services.

Several commenters say that medium-term futures contracts have increased in importance in recent years. Such a contract entitles a buyer to delivery of material at a future date between one and a few years after contract execution. The commenters observe that these contracts differ from traditional term contracts in that they involve one-time-only deliveries and that buyers ordinarily do not use them to secure long-term fuel supplies. In a sense, the commenters suggest, these contracts form an extension of the spot market to deliveries up to a few years in the future.

2. Price Information

Unlike many other commodities, most uranium contracts are not traded through a commodities exchange. Instead, a handful of entities with access to the terms of many bids, offers, and contracts develop what are called ''price indicators'' based on those transactions. Two private consulting firms—UxC and TradeTech, LLC (TradeTech)—publish monthly spot and term price indicators for uranium concentrates, conversion, and enrichment. Both also publish weekly spot price indicators for uranium concentrates.[22] Note, however, that the UxC and TradeTech indicators do not necessarily summarize completed transactions. They may be based only on offers. The UxC and TradeTech price indicators are influential; industry practice is generally to price sales contracts based on one or both of these price indicators.

There are also a number of related published prices for U_3O_8. These include a Broker Average Price (BAP) and a Fund Implied Price (FIP), both published by UxC. The former is based on pricing data from ''commodity style'' brokers that have agreed to provide information to UxC and the latter is based on the traded value of the Uranium Participation Corporation (UPC) compared to its uranium holdings.[23] UxC Uranium Market Outlook—Q4 2014, 35–37 (2014). Futures contracts for U_3O_8 are also traded through CME/NYMEX. Through this platform, futures contracts are traded with delivery dates ranging from a month to five years. *See* UxC, ''CME/NYMEX Uranium Futures (UX) Contract,'' *http://www.uxc.com/data/nymex/NymexOverview.aspx* (accessed Mar. 25, 2015); CME Group, ''UxC Uranium U3O8 Futures Quotes,'' *http://www.cmegroup.com/trading/metals/other/uranium.html* (accessed Mar. 25, 2015).

III. Analytical Approach

As noted above, section 3112(d) states that DOE may transfer ''natural and low-enriched uranium'' [24] if, among other things, ''the Secretary determines that the sale of the material will not have an adverse material impact on the domestic uranium mining, conversion, or enrichment industry, taking into account the sales of uranium under the Russian HEU Agreement and the Suspension Agreement.'' After considering this statutory language, DOE has developed a set of factors that this analysis considers in the section 3112(d)(2) assessment.

A. Overview

The USEC Privatization Act does not clearly indicate what kind or degree of effect or influence on an industry would constitute an ''adverse material impact.'' As discussed below, these words are susceptible of many meanings. Contextual clues provide some guidance in understanding the phrase, but DOE has not identified context (such as a

application for a gas centrifuge enrichment plant in late 2003. The facility, known as Urenco USA (UUSA), began operation in mid-2010, almost seven years after the license application was submitted. Given the licensing process, planning for the facility would have had to have begun well before the license application was submitted. Similarly, the timeline for AREVA's COMURHEX II conversion project included feasibility and design studies taking place between 2004 and 2007, with full production capacity reached in 2015. AREVA, ''COMURHEX II: Investing for the Future,'' Nov. 2010, available at *http://www.areva.com/mediatheque/liblocal/docs/activites/amont/chimie/plaket%20CXII%20GB%20MD.pdf.*

[21] EIA defines these contracts as those having one or more deliveries to occur after a year following contract execution.

[22] The Euratom Supply Agency (ESA) also publishes spot and term price indicators for U_3O_8 based on deliveries to EU utilities. These prices are published annually rather than monthly or weekly. *See* ESA, ''ESA Average Uranium Prices,'' *http://ec.europa.eu/euratom/observatory_price.html* (accessed Mar. 25, 2015).

[23] UPC is a publicly traded holding company that invests substantially all of its assets in uranium. UPC's stated investment strategy is to buy and hold uranium rather than actively trading in response to short-term shifts in prices. UPC, Investor Update Presentation, 17 (Aug. 2014), available at *http://www.uraniumparticipation.com/i/pdf/ppt/UPC-Investor-Update-August-2014.pdf.*

[24] In the nuclear industry, the term ''natural,'' with respect to uranium, ordinarily refers to material that contains the various uranium isotopes in their naturally occurring concentrations—most significantly, U–235 at 0.711 wt-%. Uranium can be converted into many different physical or chemical forms without necessarily altering the isotopic concentrations, and in common usage any physical or chemical form with the naturally occurring concentrations is called ''natural uranium.'' Although the USEC Privatization Act does not define the term, it appears to use ''natural uranium'' in accordance with its customary technical meaning. In particular, section 3112(a) refers to ''natural uranium concentrates'' and ''natural uranium hexafluoride'' as being species of ''uranium.'' This usage indicates that being ''natural'' is a characteristic that cuts across chemical and physical form, and confirms that ''natural'' does not refer to the form in which uranium is found in nature (uranium ore). Moreover, section 3112(d) establishes prerequisites for a transfer of ''natural uranium.'' If ''natural uranium'' were only a particular physical or chemical form, the Department would be permitted to transfer other forms of uranium without regard to the section 3112(d) conditions. For example, if ''natural uranium'' meant uranium concentrates, DOE need not make a section 3112(d)(2) determination before transferring uranium hexafluoride. DOE believes such a limited understanding of ''natural'' would not best serve the purposes of section 3112. Accordingly, DOE understands ''natural uranium'' to refer to the isotopic concentrations, regardless of the physical or chemical form.

One commenter has argued that section 3112 does not permit DOE to transfer uranium hexafluoride (except pursuant to section 3112(b)). According to the commenter, ''natural uranium'' as used in section 3112(d) does not include uranium hexafluoride, at any isotopic concentration. For the reasons just given, DOE interprets ''natural uranium'' section 3112(d) to encompass transfers of uranium hexafluoride with the naturally occurring isotopic concentrations.

statutory definition) that would unambiguously settle what an ''adverse material impact'' is.

Moreover, the meaning of the phrase is likely to depend in part on the factual context in which it is to be applied.[25] Uranium transactions can take myriad forms, and the effect of any given transaction on any one or all of these industries will depend on the facts and circumstances at the time of the transaction. DOE's inventory of uranium is changing over time, and Congress could not have anticipated the specific characteristics of every potential transaction. Thus, it would be unsurprising for the statute to describe DOE's mandate in open-ended terms, leaving DOE to elaborate details as and when DOE applied the statute over time.

Thus, the Department will need to exercise judgment to develop an understanding of ''adverse material impact,'' in its statutory context, as applicable to a given potential transfer or sale of uranium. Part of that task involves establishing an analytical framework to form the basis of and reach a determination about the impacts of DOE's transfers. The Department is responsible for analyzing relevant information in light of the statutory text and purposes to determine whether a particular sale or transfer will have an ''adverse material impact'' on the domestic uranium mining, conversion, or enrichment industry.

To make that assessment, DOE must first articulate what is the ''domestic industry'' for each of these markets. DOE interprets the word ''domestic'' to refer to activities taking place in the United States, regardless of whether the entity undertaking those activities is itself foreign. Hence, a facility operating in the United States would be part of ''domestic industry'' even if the facility is owned by a foreign corporation. DOE believes that the phrase ''uranium mining, conversion or enrichment industry'' includes only those activities concerned with the actual physical processes of mining, converting, and/or enriching uranium. Thus, acting solely as a broker for material mined, converted, or enriched by other entities does not constitute part of the domestic ''industry.'' The relevant purpose of section 3112(d) is to help preserve, to the degree possible, viable mining, conversion, and enrichment capacity in the United States. That purpose depends on the actual operation of facilities. To that end, DOE believes ''domestic industry'' should also include, to some extent, activities to develop and activate a facility in the United States, even if the facility has not yet entered production.

One commenter suggested that DOE should interpret ''domestic . . . industry'' to include secondary suppliers and supply chain companies, including remediation, reclamation, decontamination, decommissioning, and waste management. NIPC Comment of Fluor B&W Portsmouth (FBP), at 2–3. DOE believes that these other entities should not be included because doing so would not be necessary for the purpose noted above of preserving viable mining, conversion, and enrichment capacity in the United States. Participants in those industries need various services and supplies to be available, but they need not as a general matter obtain those services or supplies from domestic suppliers.

Next, DOE elaborates what it means for transfers to ''have'' an ''impact.'' DOE believes that it can appropriately fulfill the purpose of the statute by reading this phrase to refer to ''impacts'' that have a causal relationship to DOE transfers. The overall thrust of section 3112 is to permit transfers and sales of uranium to the degree consistent with various policy considerations set forth in various paragraphs.[26] Section 3112(d) calls for the Secretary's predictive judgment, before DOE engages in a transaction, whether the transaction will have an adverse material impact on the domestic uranium industries. The notion of causation is implicit in this structure. If domestic industries would experience a given negative condition regardless of whether DOE made a particular transfer, it would ill serve the purposes of the USEC Privatization Act for section 3112(d) to block the transfer.

Thus, in assessing a given transfer, DOE will essentially evaluate two forecasts: One reflecting the state of the domestic uranium industries if DOE goes forward with the transfer, and one reflecting the state of the domestic uranium industries if DOE does not go forward with the transfer. DOE will then compare these two forecasts to determine the relevant impacts on the domestic uranium industries.

Some commenters agreed that DOE's approach is reasonable. But other commenters believed DOE's approach amounted to saying DOE could justify a transfer solely on the basis that it has less impact than other factors. These commenters appear to have misunderstood DOE's analytical approach. DOE has not suggested that it will compare the impact of its transfers to the impact of other factors and consider an impact from its transfers ''material'' only if it is larger than others. Rather, DOE simply believes that if a given state of affairs would exist whether or not DOE made a certain transfer of uranium, that status should not be regarded as an ''impact'' that the transfer ''ha[s],'' for purposes of section 3112(d). Other comments argued that it should not be relevant whether a given negative outcome for domestic industry would occur independent of DOE's transfers. DOE disagrees. If, for example, a set of industry participants have halted plans to invest in production, and they would maintain that position with or without DOE transfers, it is appropriate under section 3112(d) to conclude that the transfers do not ''have'' the abandoned investments as an ''impact.''

Commenters also suggested that DOE should not try to ''justify'' transfers on the ground that DOE transfers ''are not the driver of the current negative state'' of domestic uranium industries. Whether DOE's transfers are the ''driver'' of an industry's current state is not directly at issue. The statute uses the future tense; it directs DOE to determine, before a transfer, that the transfer ''will not have an adverse material impact.'' Thus, DOE's task is to make a prediction, before engaging in a transfer, about what consequences will flow from that transfer in the future. What contribution past transfers have made to the existing situation can be important for informing DOE's predictive judgment, and this analysis appropriately considers such matters. But whether or how DOE's past transfers caused or contributed to current circumstances is not, itself, the question that section 3112(d) poses.

DOE recognizes that causation can be difficult to determine, especially with respect to something as complex as a set of three interlocking markets and industries being possibly affected by DOE transactions that may vary over

[25] Some commenters objected that the meaning of ''adverse material impact'' cannot change depending on circumstance. DOE did not suggest that it would alter its interpretation of the statutory language over time. But statutory interpretation is not simply a matter of supplying for one word, like ''material,'' a longer recitation drawn from a dictionary. Applying a statute to a given factual circumstance inevitably involves an exercise in interpretation, and no verbal formula developed *ex ante* can answer all questions that may arise. Indeed, some phrases are, by their nature, best ''given concrete meaning through a process of case-by-case adjudication.'' *INS* v. *Cardoza-Fonseca,* 480 U.S. 421, 446 (1987). ''Adverse material impact'' is such a phrase.

[26] In passing the USEC Privatization Act, Congress recognized that DOE would have a substantial uranium inventory after privatization. Congress included section 3112(d) to ensure that DOE could continue to use sales or transfers from its uranium inventory as a management tool. *See* S. Rep. 104–173, at 16–17; *see also* 141 Cong. Rec. S6106–07 (daily ed. May 3, 1995) (statement of Sen. Domenici).

time. It will often not be possible to have certainty that past transfers did or did not cause a present state of affairs, and it will be less certain that a possible future outcome was actually the result of DOE transfers. Accordingly, DOE does not interpret the statute to require certainty about what impacts its transfers will or will not have. DOE will regard its transfers as having as impacts, for purposes of section 3112(d), the consequences that can reasonably be attributed to the transfers.

DOE also notes that the statute directs DOE's attention to the ''impact'' on ''industry.'' Consistent with common understandings of these words, DOE believes a section 3112(d) analysis should address the actual effects on each industry. A set of transfers may have various influences on a given market (for uranium, conversion, or enrichment), but section 3112(d) does not instruct DOE to assess effects on the markets. Of course, market effects will be the most common mechanism through which transfers have impacts, if any, on domestic industry. But DOE will focus ultimately on the impacts to industry, rather than the market effects in the abstract. For example, if a hypothetical domestic company had locked in prices for the next ten years in long-term contracts, a decrease in prices during that time would not have an adverse impact on that company. Indeed, the price decrease could ultimately be beneficial to that company, if competitors were more exposed to and thus suffered greater harm from the price change.

With respect to assessing whether the adverse impacts of a transfer would be ''material,'' DOE observes that the word ''material'' is used to denote situations ''of real importance or great consequence.'' *See Webster's Third New International Dictionary* 31, 1392 (1961). How large consequences must be to qualify as ''material'' varies in different legal contexts. In light of the overall goals and structure of the USEC Privatization Act, DOE takes ''adverse material impact'' to mean harms that go beyond the effects of normal market fluctuations, such as those that threaten the viability of an industry.

As noted above, one purpose of the USEC Privatization Act was that DOE should manage and eventually dispose of the large legacy inventory that the privatization of USEC would leave it. In privatizing the United States Enrichment Corporation, Congress recognized that DOE would have uranium inventory left over and that this inventory would have substantial economic value. By including section 3112(d), Congress preserved the Secretary's discretion to utilize uranium transfers as a tool in managing the uranium inventory, and the substantial value embodied therein. If Congress had not wanted DOE to make productive use of its inventory, it could have prohibited all sales by the Department with or without a determination. Instead, the USEC Privatization Act explicitly directed DOE to transfer various quantities of uranium to market participants and permitted certain other transfers. 42 U.S.C. 2297h–10(b)(2), (c) & (e).

Section 3112 also provides helpful context that indicates the magnitude of industry impact that Congress considered acceptable. The statute specifically authorized material delivered under the Russian HEU Agreement to enter the U.S. market notwithstanding a preexisting suspension agreement limiting the entry of this material. 42 U.S.C. 2297h–10(b)(3), (5)–(7). The act contained annual limits on deliveries of the natural uranium content of the Russian material. The limits started at 2 million pounds U_3O_8 equivalent in 1998, and increased by 2 million pounds each year reaching a maximum of 20 million pounds U_3O_8 equivalent in 2009 and each year thereafter. 42 U.S.C. 2297h–10(b)(5).[27] For comparison purposes, this last figure represented over four times the volume of U_3O_8 produced at U.S. mines in 1996, the year the statute was passed. EIA, Domestic Uranium Production Report (2005). The size of this explicit authorization informs DOE's understanding of what impacts Congress would have regarded as ''material.'' It seems unlikely that Congress would have authorized in section 3112(b) transfers that would have been inconsistent with the policy goals of section 3112(d).

Indeed, the structure and legislative history of section 3112(b) confirm that the schedule for Russian material's entering domestic markets reflects Congress's balancing of concerns similar to those that motivated section 3112(d)(2). Congress could have simply allowed all Russian material into the United States without limitation. Instead, Congress provided a schedule that ramped up over a period of 20 years. Congress evidently balanced the competing concerns of providing a market for down-blended Russian HEU and protecting the domestic uranium industries from large-scale disruption. The schedule outlined in section 3112(b) reveals the level of market interference that Congress believed struck that balance. This notion is further confirmed by the legislative history of this provision, which specifically states that Congress was trying to balance the interests in maintaining the Russian HEU Agreement with the interests of the domestic uranium industries. *See* S. Rep. 104–173, at 14. Further, the legislative history explains that the schedule of maximum deliveries was designed to protect against disruptions to the uranium markets by providing a ''reasonable, predictable, and measured introduction of this Russian material into the domestic uranium market.'' *Id.* at 28.

The preceding discussion is not intended automatically to support transfers of up to 20 million pounds under section 3112(d). DOE must exercise judgment as to whether a given set of transfers would cause an adverse material impact, in light of market and industry conditions today. However, DOE believes that this provision provides some insight into what scale of market interference Congress considered acceptable and expected would not cause ''adverse material impact.''

B. Comments on DOE's Interpretation of Section 3112(d)(2)

Several commenters stated their belief that DOE's understanding of ''material'' sets an impermissibly high bar and would make the section 3112(d)(2) restriction meaningless. NIPC Comments of ConverDyn, at 3; NIPC Comment of UPA, at 3. DOE clarifies that it does not read section 3112(d)(2) to mean that an impact must threaten the viability of an industry to be ''material.'' That example illustrates a type of impact that would be material, but other impacts could, depending on the circumstances, also be material. Exactly what impacts would rank as ''material'' cannot be specified in advance; as noted above, ''adverse material impact'' is a phrase the meaning of which is best developed by applying it to specific situations, as in the analysis below. DOE does believe that ''adverse material impact,'' in section 3112(d)(2), should be taken to mean harmful effects of great consequence, and it adheres to the view that effects comparable to what would result from ordinary market fluctuations will usually not qualify as ''material.'' As the example of the Russian uranium supply authorized by section 3112(b) illustrates, Congress contemplated that the government would affect uranium markets to a substantially greater extent than do commercial market participants. In addition, the USEC Privatization Act left DOE with a large inventory of

[27] Sales under the Russian HEU Agreement ceased at the end of 2013.

surplus uranium. Section 3112 reflects an intent to enable DOE to reduce that inventory—and the associated storage costs the government bears—while making productive use of the uranium, so long as the domestic industries are adequately protected from harm. That framework does not suggest that DOE should be limited to the scale of participation of a typical commercial market participant.

Some commenters also stated that ''material'' should mean any impact that is greater than *de miminis.* NIPC Comment of ConverDyn, at 4; NIPC Comment of UPA, at 3–4. This suggestion is at odds with ordinary methods of statutory interpretation. Because an effect that was only *de minimis* would not really be an adverse impact at all, the word ''material'' would add little if it simply reinforced the point that section 3112(d) is concerned only with non-trivial effects. In addition, the suggested interpretation would make section 3112(d) largely irrelevant to DOE transfers as a practical matter. Nearly every transfer has some nontrivial impact on some segment of the industry; if DOE could transfer uranium pursuant to section 3112(d) only when the forecast impacts were *de minimis,* it would make use of section 3112(d) rarely if at all.[28] DOE believes section 3112(d) was meant to be a practical mechanism for managing the uranium inventory subject to certain constraints, not a restriction so severe it becomes a virtual dead letter. Consistent with that view, section 3112(e)(2) permits DOE to transfer enriched uranium in any quantity to any person ''for national security purposes.'' It would be odd for Congress to commit such open-ended authority to DOE, with such extensive discretion, for one type of transfer, while simultaneously constricting section 3112(d) transfers to essentially zero. For these reasons, DOE rejects the suggestion that any impact that is more than *de minimis* is material.

Commenters also cited examples of other meanings of ''material,'' particularly in statutes that include definitions for the term. There is no such definition in the USEC Privatization Act, however. These examples confirm that ''material'' can have a variety of meanings, depending on context, but are of little help for identifying a specific meaning for the phrase ''adverse material impact'' in the particular context of section 3112(d)(2).

[28] DOE has identified one type of transfer for which the impacts, if any, may truly be *de minimis,* namely the transfers of high-assay LEU for research reactors mentioned above in section I.D.2.e. The rarity of this circumstance demonstrates the point.

Commenters also contended that DOE's transfers would have material impacts because they would affect prices or profits by a given percentage. To the extent commenters tied these claims to specific arguments why the given numerical effects are material in current circumstances, DOE addresses those arguments below. However, some commenters appear to believe that a change in price or profits is material solely because it exceeds some threshold percentage. DOE does not believe such rigid formulas are appropriate. First, as discussed above, DOE's task under section 3112(d)(2) is to predict impacts on the domestic industries, not just market effects. How much a given change in price affects an industry depends on the circumstances, including the degree to which industry members are exposed to that price change. Second, whether a given impact is material will generally depend on the circumstances as well. As a hypothetical example, suppose a transfer had the consequence of forcing a production facility to close. That outcome might not rank as a material impact on the industry if the facility were one out of fifteen facilities industry-wide and the others were in good financial condition.

With respect to the relationship DOE observes between section 3112(d) and uranium permitted under the Russian HEU Agreement, several commenters objected to DOE's observation, for several reasons. NIPC Comments of ConverDyn, Uranerz, and UPA. Some argued that the language in section 3112(d)(2) directing DOE to ''take account'' of the Russian HEU Agreement was meant only to ensure the viability of the Agreement. Under this view, section 3112(b) was the more important provision because it permitted the reduction of weapons stockpiles. Congress knew that section 3112(b) sales might severely disrupt domestic industries, and, the argument continues, it did not want section 3112(d) transfers to interfere with the process by disrupting them further. To that end, these commenters say, the statute directed DOE to bear the section 3112(b) sales in mind in making section 3112(d) determinations, so that DOE transfers would not ''get in the way'' of the Russian HEU Agreement.

The commenters' interpretation of the ''taking account'' language seems unduly constrained. Section 3112(d)(2) does not, by its terms, indicate that DOE's goal in taking account of Russian-origin uranium sales should be to facilitate or preserve those sales. To be sure, as commenters note, the successful implementation of the Russian HEU Agreement was an important policy goal of section 3112. However, the ''taking account'' clause also covers sales under the Suspension Agreement. Congress is unlikely to have had as strong an interest in ensuring the success of the Suspension Agreement, because it was simply the settlement of a trade dispute regarding Russian uranium producers. The mention of the Suspension Agreement supports DOE's view that it should ''tak[e] account'' of the two categories of Russian-origin uranium in various ways that depend on the circumstances. When sales of uranium under the two Agreements are high, that contribution to supply should be an important consideration when DOE makes a determination under section 3112(d)(2). When sales under the Agreements decrease, that decrease in supply can also be important to a determination.

Some commenters pointed out that market participants took steps to mitigate the effects of section 3112(b) sales, for example by committing the uranium on long-term contracts. DOE recognizes that the practical consequences of section 3112(b) were not as significant as section 3112(b) would have permitted. In addition to the mitigation efforts commenters described, the actual amounts delivered have generally been lower than the section 3112(b) caps. But as DOE stressed in the Notice, it does not believe the comparison to section 3112(b) leads to the conclusion that any transfers short of 20 million pounds per year would be permissible under section 3112(d). Section 3112(d) directs DOE to predict the actual impacts of transfers, in current conditions; DOE does not seek to rely on a numerical trigger like 20 million pounds. Rather, the comparison to section 3112(b) informs DOE's understanding of what degree of impact is ''material'' in the section 3112(d) sense.

It also bears mention that DOE's use of the section 3112(b) caps to inform interpretation of section 3112(d)(2) is not the mechanism by which DOE ''tak[es] account of the sales of uranium'' under the two Russian Agreements. As commenters point out, the sales that have actually occurred under the Russian HEU Agreement were smaller than what section 3112(b) permitted. DOE takes account of these sales—as well as those under the Suspension Agreement—in its analysis, below, of impacts on the domestic uranium industries. Apart from that analysis and the amounts of actual sales, DOE considers the volumes that Congress authorized in section 3112(b) to be informative for understanding what degree of consequence would

constitute an ''adverse material impact.'' The section 3112(b) limits would be relevant in that regard even if section 3112(d) lacked the ''taking account'' clause. But the inclusion of that clause confirms DOE's view because it indicates that Congress legislated the two provisions congruently.

Section 3112(b) itself provides further evidence in support of that conclusion. It directs the President to monitor sales under the Russian HEU Agreement and report on any actions the President proposes to take ''to prevent or mitigate any material adverse impact'' the sales might have on the domestic uranium industries. But it does not require any particular presidential action. Thus, Congress evidently intended section 3112(b) sales not to have material adverse impacts but realized that they might. Notably, the possibility of material impact was uncertain enough that Congress deemed it unnecessary to mandate any preventative steps. Taken together, the structure of section 3112(b) suggests that ''material'' impacts refers to consequences of such significance that they might or might not result from sales at the rates section 3112(b) contemplated.

In general, commenters on this topic suggest that by instructing DOE to ''tak[e] account'' of sales under the Russian HEU Agreement, section 3112(d) meant to limit DOE's sales in light of the impact of the Agreement. These commenters argue that in the past DOE implicitly viewed the ''taking account'' clause as such a limit; Secretary Richardson placed a 10-year moratorium on transfers of Russian-origin uranium hexafluoride in DOE's inventory. DOE agrees that the ''taking account'' language can limit DOE's transfers: To the extent that sales under the Russian HEU Agreement are causing impacts on an industry, DOE must consider those impacts when assessing the possible impacts of a transfer it contemplates pursuant to section 3112(d). The discussion above is consistent with that view.

Finally, commenters argued that section 3112(b) sales have less impact, relative to the amount of uranium, than DOE's section 3112(d) transfers because they are capped, predictable, and transparent. DOE notes that the cap was 10 million pounds in 2002 and has now increased to 20 million pounds. Neither DOE's section 3112(d) transfers nor the section 3112(b) sales have ever reached those scales, so it seems unlikely that simply having the cap would make a difference to the actual economic impact of the transactions. DOE does recognize that the predictability of supply is an important factor, and predictability or lack thereof can increase or decrease the impact of a program of transfers. The analysis below considers this factor. With respect to transparency, as distinct from predictability, DOE believes it provides at least as much public notice about planned section 3112(d) transfers as was available for section 3112(b) sales. The Department publicly announces its determinations, each of which reflects an amount actually to be transferred; and the Department has published an accounting of the quantities of uranium it has available for transfer. By contrast, section 3112(b) sales happened through a private entity that had no obligation to release data publicly about sales. The statutory limit on sales, being much larger than the sales that actually occurred, provided little information about how sales of Russian uranium would affect the markets in practice.

One commenter pointed out that Russian-origin material continues to be available from commercial sources. NIPC Comment of ConverDyn, Enclosure, at 4. DOE believes this commenter was referring to the 2008 amendment to the Suspension Agreement discussed in Section I.D.3.b. DOE will take account of any sales under the Suspension Agreement in the analysis below.

Several commenters suggested that DOE should utilize a quantitative annual cap on transfers. Although the specific proposals varied, several suggested a rate of approximately 5.0 million pounds U_3O_8 per year. *E.g.* RFI Comment of UPA, at 9; RFI Comment of ConverDyn, at 8; NIPC Comment of Cameco, at 2–3.[29]

These commenters appear to have two chief reasons for their proposal. First, the commenters seem to think the various limits they propose are, in fact, the outside bounds of what DOE can transfer consistent with section 3112(d). Thus they would have DOE keep transfers below their preferred limits to avoid material impacts. However, DOE does not believe a quantitative trigger—whether implemented as an annual cap or only as a guideline—is a necessary or appropriate way to analyze whether DOE transfers will cause adverse material impacts. In the past, DOE has stated that, as a general matter, the introduction into the domestic market of uranium in amounts that are less than ten percent of the annual fuel requirements for U.S. nuclear power plants should not have an adverse material impact on the domestic uranium industries.[30] *See* 2008 Policy Statement, at 2; 2008 Plan, at ES–1. In July 2013, DOE noted that DOE's experience between 2008 and 2013 led it to determine that DOE ''can meet its statutory and policy objectives in regard to DOE uranium sales or transfers without an established guideline.'' In addition, DOE noted that in light of the two-year limit on the validity of a determination under section 3112(d), an established guideline was no longer necessary. 2013 Plan, at 2. DOE further notes that the global nature of the markets for uranium concentrates, conversion services, and enrichment services suggests that a focus on U.S. reactor needs will not adequately capture the impact on domestic industries. DOE therefore adheres to the views it expressed in 2013. It further notes that what impacts would be material will depend on the circumstances expected to prevail at the time of a transfer, and what impacts a transfer has will depend on those circumstances as well as on the details of the transfer. A simple rule that transfers below a certain amount are acceptable and those above are not would be inaccurate. In some circumstances, a transfer below the trigger could actually cause an adverse material impact to one or more of the domestic uranium industries; and in some circumstances a transfer above the trigger would actually not cause adverse material impacts. Rather than commit itself to a course that risks both types of inaccuracy, DOE prefers to perform the relevant analysis for each determination.

Commenters also urge DOE to maintain a cap because they believe long-term certainty about the maximum scale of transfers would mitigate the impact of the transfers and help industry attract investors. DOE recognizes that certainty and predictability are important for planning investments and industrial activities, especially in industries like the uranium

[29] One commenter suggested the possibility of waiver of future Secretarial Determinations if DOE would maintain such a cap. NIPC Comment of Cameco, at 3. The commenter did not suggest who might waive DOE's obligation to perform a determination before a transfer pursuant to section 3112(d). The statute imposes that duty and does not seem to provide a mechanism for it to be waived.

[30] Commenters argue it was impermissible for DOE to eliminate the ''cap'' they say the 2008 Plan imposed. DOE does not regard the 2008 plan as having prescribed a strict cap on transfers. The plan itself said only that transfers below ten percent of annual U.S. reactor requirements would generally not be an adverse material impact. It did not purport to prohibit DOE from making section 3112(d) determinations for transfers above that amount. Moreover, the 2008 Plan specifically stated that DOE may transfer more than the 10 percent figure for certain purposes. 2008 Policy Statement, at 2. DOE announced in July 2013 that it would no longer utilize that guideline. 2013 Plan, at 2.

industries where developing new facilities can take many years. At the same time, DOE needs some degree of flexibility for transferring uranium as appropriate—and consistent with section 3112—in support of its various missions. After balancing the value of certainty for fostering industrial investment against the mandate to make effective use of the excess uranium inventory, DOE declines to commit to a preset limit on transfers.

C. Factors Under Consideration

For these reasons, DOE believes that whether the effects of a given transfer constitute an ''adverse material impact'' should not depend on a quantitative bright-line test, but rather should be based on an evaluation of potential impacts by examining a number of factors. Accordingly, this analysis considers the effects of DOE transfers using the following six factors:

1. Prices
2. Production at existing facilities
3. Employment levels in the industry
4. Changes in capital improvement plans and development of future facilities
5. Long-term viability and health of the industry
6. Russian HEU Agreement and Suspension Agreement

While no single factor is dispositive of the issue, DOE believes that these factors are representative of the types of impacts that the proposed transfers might have on the domestic uranium industries. Not every factor will necessarily be relevant on a given occasion or to a particular industry; DOE intends this list of factors only as a guide to its analysis.

DOE notes two ways that these factors differ from the list of factors DOE provided in the March 2015 Notice of Issues for Public Comment. First, DOE has combined the first two factors listed in the NIPC, ''market price'' and ''realized prices of current operators.'' DOE continues to believe that the effect of DOE transfers in these two areas is a relevant consideration. However, DOE recognizes that market prices, in the abstract, will not always be directly relevant for assessing the impact on an industry. More important will be the prices that various industry members actually receive for their products or services, which under most circumstances is a function of both the change in price and the contours of the various contracts through which industry members sell their uranium. As DOE's focus is ultimately the effect on industry, it is appropriate to consider these two aspects of price together. Second, DOE has added a factor regarding the Russian HEU Agreement and Suspension Agreement. Although the analysis below, to a certain extent, considers these transfers as part of the discussion for all of the factors, DOE believes it is appropriate to discuss these two Agreements separately as well.

Several comments submitted in response to the March 2015 Notice of Issues for Public Comment refer to some or all of these factors. Uranerz Energy Corporation expressed its view that the six factors listed in the NIPC provide significant context for analyzing the impacts to the domestic uranium industries. NIPC Comment of Uranerz, at 1. Similarly, Fluor B&W Portsmouth (FBP), contractor to DOE for cleanup services at Portsmouth, noted that these factors are ''reasonable and indicative of the types of impacts that DOE Transfers of Excess Uranium could have on the domestic industries.'' NIPC Comment of FBP, at 3. Nuclear Fuel Services, Inc. (NFS), which conducts down-blending services for DOE through a subcontract with WesDyne, suggested that DOE should consider the potential impact of DOE transfers on the ability of DOE to meet nonproliferation and defense missions. NIPC Comment of NFS, at 2–3. While DOE agrees that these policy concerns can be significant to DOE's decision whether to undertake a given transfers, DOE does not believe these concerns are relevant to the prerequisite section 3112(d)(2) finding on whether DOE transfers will have an adverse material impact on the domestic uranium industries.

ConverDyn states that DOE should consider ''displaced sales'' as a separate factor. NIPC Comment of ConverDyn, at 6. DOE disagrees that this should be considered separately. DOE believes that displaced sales are an aspect of production at existing facilities. Thus, these considerations fit within that category and do not need to be considered separately. ConverDyn also commented that DOE appears to give double weight to prices by considering both ''market price'' and ''realized price.'' *Id.* at 7. As discussed above, DOE has combined these two concepts into a single factor, ''prices.'' However, as discussed above, DOE continues to believe it is appropriate to consider the effect of DOE transfers on ''market price'' and ''realized price.''

In any case, it bears emphasis that DOE does not place extra ''weight'' on price or any other individual factor. DOE's analysis considers all the factors taken together as a whole. DOE has not assigned specific ''weights'' to the factors. To the extent that some considerations overlap multiple factors, DOE will take this into account in its analysis. ConverDyn also argues that the long-term viability and health of the industry factor should be ''of minimal weight'' because the Secretarial Determinations are only valid for two years. *Id.* at 8. As stated above, DOE has not assigned any particular weight to each factor. DOE agrees that the relevant analysis for this factor should focus on the impact of DOE transfers on the long-term viability and health of each industry, not simply on the long-term prospects for each industry in the abstract. Finally, ConverDyn suggests that DOE should expressly consider the need for domestic capacity to produce material for national defense needs. *Id.* DOE notes that section 3112 of the USEC Privatization Act implements a policy of ensuring, to the degree consistent with the statute's purpose, that domestic capacity remains within the uranium mining, conversion, and enrichment industries. DOE believes that section 3112(d), which requires the Secretary to determine whether DOE transfers will have an ''adverse material impact'' on these industries, itself addresses, in part, the national security concern ConverDyn mentions.

In addition to the above discussion, several comments in response to the December 2014 Request for Information suggested additional factors that DOE should consider. DOE has chosen not to consider those factors in the manner commenters suggested, for the reasons given in the March 2015 Notice of Issues for Public Comment.[31]

Several commenters also inquired whether the analytical method DOE is now articulating is consistent with the analyses supporting prior section

[31] One commenter takes issue with DOE's assertion in the NIPC that many domestic producers are part of multiline businesses, so that their share prices are not related solely to uranium markets. The commenter does not dispute DOE's related observations that share price reflects myriad inputs such as the nature of company management, gearing ratio (debt vs. equity), inflation, and the particular risks associated with the uranium market (such as the influence of political changes, like the shift in energy policy in Germany, or public responses to nuclear accidents). Because of this complexity, it is difficult to meaningfully attribute a change in a company's share price to DOE transfers; and it is also not fully meaningful to predict how a given change in share price will affect investment decisions. Indeed, while the commenter contends that ERI's report shows market capitalization to be tied to market prices, in fact ERI notes that producers' share prices have not reacted to recent price increases as much as could be expected based on the rough correlation between share prices and market prices in the aftermath of the Fukushima disaster. For these reasons, DOE remains convinced that analyzing the economic case for investments in new production is a more reliable and appropriate method for assessing the impact of transfers than would be a focus on share prices.

3112(d) determinations. While today's approach is broadly tracks DOE's analyses of past transfers, DOE recognizes that this analysis elaborates in much greater detail than DOE has provided before. The level of detail with which DOE has performed this analysis, the set of factors being considered, and the process in which DOE has engaged are appropriate for this determination for several reasons, including the scale of the transfers considered in this analysis and the rate at which market conditions have changed in the recent past. Depending on the circumstances, a different approach may be warranted for subsequent determinations.

IV. Assessment of Potential Impacts

This section assesses the potential impacts of DOE transfers at the levels and for the purposes described above in Section I.D.1. The overall volume of transfers for cleanup services at Portsmouth and down-blending services in each year from 2015 to 2024 is provided in Table 3. Although this assessment focuses on the impacts of transfers in the next few years, parts of the analysis make assumptions about transfers under these programs in future years.

This assessment assumes that DOE transfers for cleanup at the Portsmouth Gaseous Diffusion Plant will continue at the preexisting rates through the first six months of 2015. Beginning in July 2015, DOE would transfer at a rate of 1,600 MTU per year of natural uranium hexafluoride. DOE has a finite amount of natural uranium hexafluoride. DOE anticipates that at this rate, this material would be exhausted in the year 2020. Transfers for down-blending services would decrease to a total of no more than 60 MTU of enriched uranyl nitrate at an assay of 4.95 wt-% in 2015 and each year thereafter. DOE assumes transfers for down-blending will continue at this rate throughout the next 10 years Together, the natural uranium and LEU to be transferred each year are the equivalent of 2,100 MTU contained in uranium concentrates, 2,100 MTU as UF_6 in conversion services, and 520,000 SWU of enrichment services.

TABLE 3—VOLUME OF TRANSFERS FOR PORTSMOUTH CLEANUP AND HEU DOWN-BLENDING IN THE "ASSESSED CASE"

	Concentrates (MTU/million lbs U_3O_8)	Conversion services (MTU as UF_6)	Enrichment services (SWU)
2015	2,500/6.5	2,500	520,000
2016	2,100/5.5	2,100	520,000
2017	2,100/5.5	2,100	520,000
2018	2,100/5.5	2,100	520,000
2019	2,100/5.5	2,100	520,000
2020	992/2.6	992	520,000
2021	500/1.3	500	520,000
2022	500/1.3	500	520,000
2023	500/1.3	500	520,000
2024	500/1.3	500	520,000

In addition to the transfers listed in Table 3, this assessment also includes potential impacts associated with transfers that are not subject to section 3112(d). Specifically, this analysis includes prior transfers of depleted uranium hexafluoride to Energy Northwest, prior and continuing transfers to the Tennessee Valley Authority of blended low-enriched uranium, potential future transfers of off-specification uranium, and potential future transfers of depleted uranium hexafluoride to GE-Hitachi Global Laser Enrichment.[32] These transfers are discussed above in Section I.D.2.[33]

Collectively, this assessment refers to the transfers described above as the "assessed case." Consistent with the analytical approach described above, this section reflects comparison of two forecasts: one reflecting the state of each domestic uranium industry if DOE goes forward with transfers at this level, and one reflecting the state of each domestic uranium industry if DOE does not go forward with these transfers.

A. Uranium Mining Industry

The domestic uranium mining industry consists of a relatively small number of companies that either operate currently producing mines or are in the process of developing projects expected to begin production at some point in the near future. These projects are mostly concentrated in the western states—in recent years, there have been producing facilities in Arizona, Nebraska, Utah, Texas, and Wyoming. Most uranium mining facilities are owned and operated by publicly traded companies based in the United States or Canada. According to DOE's Energy Information Agency ("EIA"), production from domestic producers in 2014 totaled approximately 4.9 million pounds U_3O_8. EIA, Domestic Uranium Production Report Q4 2014, 2 (January 2015). For comparison, the World Nuclear Association (WNA) reports that worldwide production in 2013 was approximately 155 million pounds U_3O_8.

1. Prices for Uranium Concentrates

The effect of DOE transfers on prices is one of the chief vehicles through which the transfers can cause impacts on an industry. Accordingly, DOE has considered numerous inputs to forecast how transfers in the assessed case will affect prices. DOE analyzes both market prices and the prices that, on average, industry actually realizes for its products. Realized prices may be more significant for assessing the impact of transfers, but, as discussed below, they are not necessarily the same as market prices at any given time.

As described above, market prices for uranium concentrates are generally described in terms of the spot price and the term price. Although there are other types of published uranium prices, these two prices are the ones most frequently used as the basis for pricing terms in contracts for the purchase and sale of uranium concentrates. This section discusses the potential impacts

[32] Although some of these transfers have already taken place, DOE nevertheless recognizes they can affect the uranium industries in future years. DOE believes it is reasonable to view these transfers as affecting the market in the years and quantities ERI analyzes—typically one year prior to the material being reloaded into a reactor for uranium concentrates and conversion, and six months prior for enrichment.

[33] This assessment also takes account of sales of uranium under the Russian HEU Agreement and the Suspension Agreement. However, these transfers are considered as part of the background market, and are not part of the "assessed case."

of DOE transfers on these two prices.[34] For reference, as of March 30, 2015, UxC's spot price indicator was $39.50 per pound U_3O_8 and its term price indicator was $49.00 per pound U_3O_8.

DOE has reviewed several different estimates of the effect of DOE transfers on the market prices for uranium concentrates based on different economic models. These estimates appear in market analyses from four different uranium market consultants: ERI, TradeTech, NAC International (NAC), and UxC. DOE has reviewed and evaluated to the extent possible the methodology, assumptions, data sources, and conclusions of each of the market analyses.

a. Energy Resources International Report

DOE tasked ERI with estimating the effect of DOE transfers on the market prices for uranium concentrates. In the 2015 ERI Report, as in previous reports, ERI estimated this effect by employing two different types of model that rely on somewhat different assumptions and methods: a market clearing price model and an econometric model. For its market clearing price model, ERI constructs individual supply and demand curves and compares the clearing price with and without DOE transfers.[35] To develop its supply curves, ERI gathers available information on the costs facing each individual supply source. ERI then uses that information to estimate the marginal cost of supply for each source using a discounted cash flow model. 2015 ERI Report, 41 n.22. To develop its demand curve, ERI assumes a perfectly inelastic demand curve based on its Reference Nuclear Power Growth forecast.[36] ERI develops this forecast by combining estimates of the needs and reload schedules for operating plants with projections about future reactor retirements and new development. 2015 ERI Report, 17–18. The second model that ERI used to predict the effects of DOE transfers on the spot price for uranium is an econometric model. ERI compared the monthly spot and term market prices published by TradeTech with published offers to sell uranium for delivery within one year of publication and published inquiries to purchase uranium for delivery within one year. Based on this information, ERI developed a multivariable correlation to estimate how the market prices would respond to the availability of new supply from DOE. 2015 ERI Report, 50.

Several commenters requested that DOE subject the 2015 ERI Report to peer review. *E.g.* NIPC Comment of UPA, at 9; NIPC Comment of ConverDyn, Enclosure, at 1. DOE is not obligated to subject the 2015 ERI Report to peer review. DOE also does not believe the lack of peer review is a reason to doubt the ERI Report. Peer review is not appropriate in all circumstances, particularly outside of the scientific research context; and market analyses like ERI's are commonly not subject to peer review. DOE has reviewed the 2015 ERI Report for completeness and evaluated ERI's methodology, assumptions, and conclusions, particularly in comparison to other reports submitted by commenters. Meanwhile, DOE made the 2015 ERI Report available for public review through the March 2015 Notice of Issues for Public Comment. DOE also made public in May 2014 an analogous report that ERI prepared to assist the deliberations for the 2014 Determination. The analytical methods in the 2015 report are largely the same as those ERI used in the 2014 report. The public has thus had opportunities to offer substantive criticisms of ERI's analyses. One commenter points out that the Office of Management and Budget has advised that notice-and-comment procedures for agency rulemaking would not be considered an adequate substitute for peer review. DOE notes, however, that the concern motivating this advice was that the relevant experts may not file comments in such a process.[37] This concern seems less significant here, because commenters on the RFI submitted reports that three expert uranium market consultancies prepared specifically to address DOE's proposed transfers. To the extent commenters offered critiques of ERI's work, DOE has considered that input in its evaluation of the 2015 ERI Report.

After reviewing the 2015 ERI Report and ERI's explanation of its methodology, as well as comments such as those that provided additional or alternative forecasts of market prices, DOE believes that ERI's first methodology described above is reasonable for estimating the impact of DOE transfers in the long-term. The methodology is consistent with common economic principles applicable to a competitive market. In general in such a market, competition from DOE-sourced uranium can be expected to displace units of supply that have the highest marginal cost. Given buyers that demand uranium at the lowest price available, the displacement of those supplies would cause the price to decrease towards the highest marginal cost of the remaining supplies. However, some producers with relatively high marginal cost have entered into long-term contracts based at least partially on fixed price mechanisms. Under such circumstances, DOE-sourced uranium might not immediately displace units of supply with the highest marginal cost. Over the longer term, these fixed price contracts will eventually expire and the higher marginal cost producers would have to enter into new contracts at the then-prevailing market prices. Therefore, DOE believes the price for uranium concentrates reflects an ordinary price-setting mechanism over the long term.

In a market with elastic demand, calculating the effect of an addition to supply would be more complicated than ERI's analysis. ERI assumes a perfectly inelastic demand curve, and in that case the ERI analysis is consistent with the pricing mechanism just described. As stated above, it appears that the uranium concentrate market exhibits behavior suggesting that demand is relatively inelastic, but perhaps not completely inelastic. To the extent that demand is at all elastic, this would tend to dampen the price effect of DOE material. However, given that ERI's assumption about the market is conservative, in that it will tend to produce overestimates of the effect of DOE's transfers on prices, DOE believes it is reasonable for achieving the purposes of this analysis.

ERI relies upon an extensive collection of data about the production costs for various aspects of supply. ERI has explained the various sources from which it collects data about the different primary producers. ERI then applies a discounted cash flow analysis to determine an expected production cost. Where information is not available publicly, ERI makes assumptions based on information from similar production facilities. DOE believes that this approach would yield reasonably accurate data because most of the uranium producers are publicly traded companies that must disclose company financial and production information to

[34] DOE further notes that several of the other published uranium prices described in Section II.E appear to be based—either directly or indirectly—on either the spot or term price. To the extent there are differences between these and other published prices, DOE believes that the behavior of the spot and term price is representative of changes its transfers may cause in other prices.

[35] The market clearing price is the price at which quantity supplied is equal to quantity demanded.

[36] In other words, ERI assumes that demand for uranium will stay the same regardless of variations in market price.

[37] Office of Management & Budget, Final Information Quality Bulletin for Peer Review, (Dec. 16, 2004), available at *https://www.whitehouse.gov/sites/default/files/omb/assets/omb/memoranda/fy2005/m05-03.pdf.*

regulatory agencies. DOE also notes that this approach to data collection about the industry appears to be standard among similar consulting firms. DOE is aware of no errors that would call ERI's data and methodology into question. In addition, the cost curve that ERI constructed from its data is comparable to analogous curves published by its industry peers.

DOE tasked ERI with estimating the effects of DOE transfers under three scenarios.[38] Under Scenario 1, DOE would transfer 2,055 MTU per year in the form of natural UF_6 and 650 MTU natural uranium equivalent per year of LEU for a total of no more than 2,705 MTU per year. Under Scenario 2, DOE would transfer 1,410 MTU per year in the form of natural UF_6 and 445 MTU natural uranium equivalent per year of LEU for a total of no more than 1,855 MTU per year. Under Scenario 3, DOE would transfer no uranium under these two programs. The transfer rates in these scenarios refer only to the level of uranium transfers for cleanup at the Portsmouth Gaseous Diffusion Plant and down-blending of LEU. For each scenario, ERI also analyzes the impacts of transfers under the following programs: TVA BLEU, Energy Northwest depleted uranium, potential future transfer of off-specification uranium, and a possible future sale of depleted uranium currently under negotiation. 2015 ERI Report, 21–32. The level of transfers across these three programs is the same in all three scenarios, and ERI's predictions about market price reflect these transfers as well as the cleanup services and down-blending transfers.

ERI notes that uranium transfers do not necessarily impact the market at the time of transfer. In general, the market impact will take place at the point in time where the transfers displace commercial supply. This can be estimated based on the expected schedule for delivery as reactor fuel. Thus, even though most of the TVA BLEU and all of the Energy Northwest transfers have already taken place, ERI estimates that these transfers will affect the market at various times in the future based on the expected delivery schedule. 2015 ERI Report, 21–22. Given that these transfers are targeted for specific reactors on predictable time-frames, DOE believes it is reasonable to assume that these transfers affect the market at the point when they displace commercial supply.

The transfer rates analyzed by ERI for down-blending services and cleanup at the Portsmouth Gaseous Diffusion Plant are summarized in Table 4. The assessed case is included for reference. Transfers under the other three programs mentioned above are included in ERI's analysis but are not included in this table because they are the same under any of the scenarios.[39]

TABLE 4—DIFFERENT SCENARIOS CONSIDERED IN THIS ANALYSIS

MTU natural uranium equivalent			
	Portsmouth cleanup	Down-blending	Total
ERI Scenario 1	2,055	650	2,705
ERI Scenario 2	1,410	445	1,855
ERI Scenario 3	0	0	0
Assessed Case (2016 and after)	1,600	500	2,100

Using its market clearing approach, ERI estimates that DOE transfers will have the effects listed in Table 5. For each year ERI included (2015–2024), the relationship between the amount of transfers under each scenario and the price effect is essentially linear. Compare Table 3.6 to Table 4.1 of 2015 ERI Report, 25–26, 45. This linearity is unsurprising, because the slope of ERI's cost curve does not change much as a function of supply at the levels of current supply. Therefore, the price effect of DOE transfers under the assessed case can be interpolated from ERI's estimates. Table 5 presents ERI's estimates of the price effect of DOE transfers for all three scenarios and DOE's interpolation of the price effect for the assessed case.[40]

TABLE 5—ERI'S ESTIMATE OF EFFECT OF DOE TRANSFERS ON URANIUM CONCENTRATE SPOT AND TERM PRICES IN $ PER POUND U_3O_8

[Market clearing approach]

2015 ERI Report				
	ERI Scenario 1	ERI Scenario 2	ERI Scenario 3	Assessed case (interpolated)
2015	$3.00	$2.10	$0.30	$2.80
2016	2.80	1.90	0.10	2.20

[38] One commenter suggests that DOE should not have tasked ERI to consider specific scenarios; instead the commenter states that DOE should have asked ERI to evaluate the ''optimal conditions for transfers, including how to minimize the adverse impact of the transfers on domestic industry while also maximizing the benefit to DOE.'' NIPC Comment of ConverDyn, Enclosure, at 9. As the impact of DOE transfers depends heavily on the specific circumstances, it is unlikely that there is a single ''optimal'' level of transfers. DOE believes a more appropriate approach is for DOE to seek out information regarding how its uranium transfers will affect the domestic uranium industries—including through tasking ERI to analyze these effects—and then for DOE to assess whether those effects amount to an adverse material impact on one or more of the domestic uranium industries.

[39] Under each of the three scenarios analyzed by ERI and the assessed case, the annual rate listed in Table 4 represents the rate only until uranium available for the Portsmouth cleanup is exhausted. Under scenarios 1 and 2 and the assessed case, this will occur by 2019, 2021, and 2020, respectively. The rates transferred for down-blending are the same throughout the study period.

[40] Note that to infer the price effect, DOE has not simply interpolated the 2,100 MTU figure between the annual rate for Scenarios 1 and 2. As discussed above, the appropriate time for assigning a price effect to a quantity of transferred uranium is the time at which it would displace commercial supply. In addition, both Scenario 2 and the assessed case involve transferring natural uranium more slowly than Scenario 1, yet DOE assumes (as ERI did) that it will continue transferring natural uranium until it exhausts its current inventory. Thus, in Scenario 2 and the assessed case, the Department will be transferring uranium in later years when, under Scenario 1, natural-uranium transfers would have ceased. The Department's interpolation reflects these calculations.

TABLE 5—ERI'S ESTIMATE OF EFFECT OF DOE TRANSFERS ON URANIUM CONCENTRATE SPOT AND TERM PRICES IN $ PER POUND U_3O_8—Continued

[Market clearing approach]

	2015 ERI Report			
	ERI Scenario 1	ERI Scenario 2	ERI Scenario 3	Assessed case (interpolated)
2017	2.70	1.80	0.00	2.10
2018	3.30	2.50	0.60	2.70
2019	2.50	3.00	1.20	3.20
2020	2.80	4.00	2.10	3.10
2021	3.00	3.20	2.40	2.90
2022	2.70	2.50	2.10	2.60
2023	3.20	3.00	2.50	3.10
2024	2.60	2.40	2.00	2.50
Average (2015–2024)	2.80	2.60	1.30	2.70

It is important to emphasize that this is not a prediction that prices will drop by the specified amount once DOE begins transfers following a new determination. A level of price suppression consistent with the estimate for Scenario 1 would, in this model, already be roughly reflected in the current market price because DOE is currently transferring uranium at that rate. 2015 ERI Report, 44. The price suppression that ERI estimates would persist under Scenario 3 is largely attributable to past DOE transfers, from which some of the uranium is still expected to be entering the market in future years. Similarly, if DOE begins transferring at the level of the assessed case, instead of at current rates, a positive effect on market prices of $0.60, compared to existing prices, could be expected in 2016, the first full year of DOE transfers at the rate of 2,100 MTU per year.

One commenter argues that the price effect described by ERI under Scenario 1 is not already built into current market prices and suggests that the price effect described by ERI should be cumulative. NIPC Comment of UPA, at 9. This commenter appears to misunderstand the nature of ERI's analysis. ERI's market-clearing approach is based on the economic principle that the market price will tend toward the competitive equilibrium price, *i.e.* the price at which the demand curve intersects the supply curve. The existing supply and demand curves include DOE transfers at the existing rates. Thus, the current market price should reflect, in part, this level of supply.[41] The price effect estimated by ERI is based on a calculation of where the two curves would intersect in the absence of DOE-sourced material. ERI uses its production data to estimate the amount of U_3O_8 that will be supplied *each year* over the next ten years, and uses these annual supply curves to estimate the price effect. 2015 ERI Report, 42. Since ERI is comparing the volume of DOE transfers in each year to the expected amount of supply *in that year,* these estimates take account of future changes in supply. For these reasons, it would be inappropriate to add the estimated price effect in separate years together, as the commenter proposes to do. In addition, the commenter's argument that adding 2,705 MTU to a market will necessarily cause a further price decrease does not take account of the fact that material is continually produced and consumed over time. Transfers at a rate of 2,705 MTU per year would be at the same rate as (or slightly below) transfers in the past few years. It is appropriate to assess the effect of that rate of transfers in light of the ongoing rates of production and consumption. DOE notes that the commenter's suggestion is also contrary to the forecasts of the three other market reports discussed below.

ERI also used its econometric model to estimate the effect of DOE transfers on the spot market price. As with ERI's market clearing price analysis, the relationship between the average volume of DOE transfers and ERI's estimated price effect over each time period is roughly linear. Thus, the price effect of transfers at the levels in the assessed case can be interpolated.[42] ERI's predictions based on its econometric model and the interpolated price effect for the assessed case are summarized in Table 6. By comparison to the market clearing analysis, the econometric model deals with short-term supply and demand and spot prices. Existing market prices should reflect already ongoing transfers at the levels of Scenario 1. Thus, on ERI's analysis prices already exhibit a level of price suppression similar to the level predicted in the near term under Scenario 1. 2015 ERI Report, 52–53. Thus, ERI's econometric model estimates suggest that if DOE begins transferring at the lower level represented by the assessed case, a positive influence on market prices approximately $0.40 would be expected in the near term.

[41] As noted above, the majority of uranium production is sold on long-term contracts. While DOE has been transferring at a rate at or below 2,800 MTU per year since 2012, contract terms may run 10 years. Thus, the market may not have fully equilibrated in response to continued transfers at the current rate.

[42] See note 40 above for details of how DOE performs the interpolation.

TABLE 6—ERI'S ESTIMATE OF EFFECT OF DOE TRANSFERS ON URANIUM CONCENTRATE SPOT PRICE IN $ PER POUND U_3O_8

[Econometric model]

2015 ERI Report		
	Estimated price effect (2015–2017)	Estimated price effect (2018–2024)
ERI Scenario 1	$2.40	$5.10
ERI Scenario 2	1.70	4.80
ERI Scenario 3	0.30	2.00
Assessed Case (Interpolated)	2.00	4.80

DOE notes that certain assumptions in the model seem relatively uncertain over the longer term. The basic nature of the model is that ERI calculated a functional relationship between published prices and certain supply and demand variables representing, in essence, uncommitted supply and demand. ERI established this relationship by means of statistical correlations between past prices and past supply and demand variables. The model then predicts future prices based on the future course of the supply and demand variables. However, forecasts of uncommitted supply and demand require assumptions not only about how supply and uranium requirements will evolve, but also about how suppliers and purchasers will vary their mix of long-term and short-term purchasing. In the short-term, the mix of long- and short-term purchasing can be predicted based on the mix in recent years and on the estimates of uncovered supply. Such forecasts become significantly less reliable for later years. Thus, for example, market consultant UxC provides only limited future projections of future contracting activity in its annual Uranium Market Outlook—[REDACTED]. UxC Uranium Market Outlook—Q4 2014, 63, 66 (2014). Consequently, while DOE believes that ERI's econometric model provides a reasonable estimate of the response of the spot price to DOE transfers in the near term, it believes estimates of this response in future years will be increasingly less reliable the further out in time the estimate.

Commenters urge DOE to distinguish between spot sales, term sales, and other types of ''forward sales.'' Cameco Corporation (Cameco) states that forward delivery contracts are ''simply contracts along the forward price curve, which is essentially the spot price with a minor adjustment for carrying costs.'' NIPC Comment of Cameco, at 3. Similarly, ConverDyn states that a new market has arisen for ''buy and hold'' or ''carry trade'' sales that should be characterizes as ''an extension of the spot market to approximately a 3-year term.'' NIPC Comment of ConverDyn, Enclosure, at 5. DOE recognizes that market participants use a range of contracts with characteristics that fall somewhere between the ''traditional'' term contracts and spot contracts described by commenters. EIA defines a ''spot contract'' to call for delivery of the entire contracted amount within one year. A ''term contract''—of short, medium, or long term—involves one or more deliveries after one year. A contract that would be a ''term contract'' under this definition may influence either the spot market or the term market (as defined by UxC and TradeTech) more or less depending on various contractual terms such as length of time before initial delivery, number of deliveries, and the pricing mechanism. Consistent with this notion, and as noted above in Section II.E.2, sources other than the UxC and TradeTech offer price indicators for future-delivery contracts that appear to be similar to what commenters describe.

With respect to DOE transfers affecting the spot market, ERI assumes that 50% of DOE transfers for cleanup at Portsmouth are introduced through term contracts. 2015 ERI Report, 34. ERI's assumption relies in part on statements by Traxys North America LLC (Traxys), the entity that currently purchases the material that DOE transfers to Fluor B&W Portsmouth for cleanup work at the Portsmouth Gaseous Diffusion Plant. Traxys has stated it sells as much as 90% of the material it purchases from Fluor under forward delivery contracts that do not affect the spot market. Declaration of Kevin P. Smith, *ConverDyn* v. *Moniz,* Case no. 1:14–cv–01012–RBW, Document 17–7, at ¶ 14 (July 7, 2014); RFI Comment of Traxys, at 1. Some of the commenters that made observations about the difference between forward delivery contracts and term contracts also rejected ERI's assumption because, these commenters say, the Traxys sales are actually spot sales even if they are for future delivery.

DOE notes that ERI's assumption that only 50% of these sales enter the term market is conservative, in that Traxys claims this figure is closer to 90%. In any case, if in fact more or less than 50% of DOE transfers for Portsmouth cleanup in fact are not sold through term contracts—in that they do not affect the term price indicators published by UxC and TradeTech—such an error in ERI's assumptions would simply decrease the reliability and certainty of ERI's econometric forecast in the mid- to long-term.[43] As described above, DOE concludes that this analysis is likely to be less reliable over the longer term anyway, because predictions about uncommitted supply and demand in future years are uncertain. Comments about the nature of Traxys's sales do not call into question the utility of ERI's econometric analysis for near-term forecasting, because commenters do not dispute that Traxys sells at least 50% of its material on contracts with deliveries more than a year in the future.[44] Even if those deliveries would affect future spot prices, it is appropriate for ERI's econometric model not to include the material in present supply.[45]

[43] ERI's report includes tables laying out how much DOE-sourced material will enter each spot market—uranium, conversion, and enrichment—in coming years. These tables would be relevant for comparing the scale of DOE's transfers to the volume of uncommitted supply and demand in the various markets. However, as explained in the NIPC, DOE does not consider such a comparison, on its own, as useful for assessing the impact of transfers as forecasts about price.

[44] Commenters suggest that sometimes a seller of a future-delivery contract will ''forfeit'' its contract. They do not claim Traxys does so with DOE-sourced material.

[45] In the analysis ERI prepared for the Department's deliberations on the 2014 Determination, it made a similar assumption that around 50% of the material transferred for cleanup services at Portsmouth would only affect term markets. If in fact those sales have essentially been one- to three-year spot sales, the material transferred in 2012 through 2014 could be affecting spot markets at present and in the near term. The

Continued

Furthermore, ERI's market clearing approach forecasts how prices will respond to changes in supply over the longer term and depends on the overall level of supply rather than on the specific mix of spot versus term contracts in a given year. Accordingly, ERI's market-clearing analysis did not use the assumption about Traxys's mix of spot and term deliveries of DOE-sourced uranium.

b. TradeTech Report

The Uranium Producers of America (UPA) attached to its comment in response to the RFI a market analysis it commissioned from TradeTech, LLC, a uranium market consultant. RFI Comment of UPA, Attachment, TradeTech, ''UPA DOE Material Transfer Study'' (2015) (hereinafter ''TradeTech Report''). A summary of TradeTech's estimates appears in Table 7. TradeTech explains that it estimated the price effect of DOE transfers using its proprietary Dynamic Pricing Model. This model uses an econometric forecasting approach to estimate the equilibrium between two dimensions TradeTech calls ''active supply'' and ''active demand.'' [46] In its estimates, TradeTech assumes that 50 percent of DOE transfers enter the spot market and 50 percent enter the term market. TradeTech Report, 14. Using its model, TradeTech estimates that DOE's transfer reduced the spot price by an average of $3.55 per pound between January 2012 and December 2014. TradeTech Report, 15. TradeTech also estimates that continued DOE transfers at current rates would reduce the spot price by an average of $2.43 per pound between January 2015 and December 2016. TradeTech Report, 20.

DOE understands this ''reduction'' to mean, as with ERI's analysis, not an additional decrease in prices beginning in January 2015, but a continued price suppression. In other words, TradeTech suggests that if DOE ceased transferring at current rates then prices could be higher by an average of $2.43 per pound in 2015 and 2016.

TradeTech also provides estimates for the effect of DOE transfers at several decreased transfer rates. If DOE transfers decreased to 75% of current levels, TradeTech estimates that the spot price would increase by an average of $0.53 per pound between January 2015 and December 2016. TradeTech Report, 26.[47] Based on TradeTech's estimate of the price suppression of DOE transfers at current levels, it appears that TradeTech is estimating that price suppression at 75% of current levels would be $1.90. If DOE transfers decreased to 50% of current levels, TradeTech estimates that the spot price would increase by an average of $1.10 per pound between January 2015 and December 2016. TradeTech Report, 25. This corresponds to a price suppression of $1.33. If DOE transfers decreased to 25% of current levels, TradeTech estimates that the spot price would increase by an average of $1.73 per pound between January 2015 and December 2016. TradeTech Report, 24. This corresponds to a price suppression of $0.70. The TradeTech Report does not state the numerical volumes that correspond to these decreased transfer rates. However, DOE notes that the 2,100 MTU rate is slightly above 75% of the level included in the May 2014 Determination. Thus, DOE believes that TradeTech's ''75%'' figure is roughly equivalent to, although slightly below, that level.

TABLE 7—TRADETECH'S ESTIMATE OF EFFECT OF DOE TRANSFERS ON URANIUM CONCENTRATE SPOT PRICE IN $ PER POUND U_3O_8

TradeTech Report	
Transfer rate (compared to current)	Estimated price effect (2015–2016)
100%	$2.43
75%	1.90
50%	1.33
25%	0.70

TradeTech's forecast for the scenario in which DOE continues transferring uranium at current rates is fairly similar to the forecast ERI generated for that scenario using its econometric model. This apparent agreement could be taken as confirmation that the forecasts are reasonable. Alternatively, the agreement between the two could just indicate that TradeTech and ERI have applied similar mathematical tools to similar inputs and modeling assumptions. It does not necessarily validate either the assumptions or the choice of mathematical model.

As with ERI's econometric model, DOE notes that TradeTech's assumptions about the amounts of uncommitted supply and demand seem relatively uncertain over the longer term because they depend on the actions of individual market participants that may reflect economic influences about which little information is available. For example, a strategic buyer or seller of uranium does not have to buy uranium at a given time; that participant may or may not contribute to uncommitted supply and demand depending on current prices, the participant's expectations of prices, and other factors. In responding to the possibility of such effects, ERI assumes that uncommitted supply and demand will repeat their courses of recent years. Meanwhile TradeTech introduces a ''quadratic coefficient to capture market exuberance, which measures market momentum.'' TradeTech Report, 14. Although the mix of long- and short-term purchasing can likely be predicted in the short-term based on prior contracting activity, forecasts based on this type of data would be significantly less reliable in the long-term.[48]

For reasons like these, although TradeTech's forecast based on uncommitted supply and demand may provide a reasonable estimate of the price response of DOE transfers in the short term, DOE believes the price response over the medium- and long-term is most appropriately estimated and forecast using information and assumptions about overall demand and supply. ERI's ''market-clearing'' model is a reasonable implementation of this approach.

c. NAC International Report

Fluor-B&W Portsmouth attached to its comment in response to the RFI an April 2014 market analysis from NAC

econometric analysis of future transfers need not account for that material explicitly, because existing uncommitted supply and demand already reflect those quantities.

ERI assumed that the other past transfers included in the assessed case—such as the blended LEU provided to the TVA—are effectively on term contracts. Commenters do not contest that characterization, and DOE believes it is reasonable to assume these materials are not appearing on spot markets.

[46] TradeTech states that the uranium markets are relatively illiquid and are characterized by periods of high price volatility. TradeTech Report, at 2–5. It does not appear that TradeTech is suggesting that DOE transfers significantly affect these characteristics of the market. Instead, it appears that TradeTech believes these are mechanisms by which DOE transfers impact the market price. DOE assumes that TradeTech's prediction of the price effect of DOE transfers reflects these market characteristics that TradeTech highlights.

[47] Figures 16–19 of the TradeTech Report show TradeTech's estimates for the price impact at a range of different transfer rates. Although these charts and the related text refer to ''Transfers at [25, 50, or 75] Percent of Established 2014 Volumes,'' it appears that these charts actually reflect an estimate for a 25%, 50%, or 75% *decrease* relative to current levels, rather than transfers at the specified percentage of current levels.

[48] In addition, TradeTech has assumed that 50% of the uranium that DOE transfers ultimately goes on the term market. As noted above, commenters suggest that assumption is incorrect because, they say, the material is actually sold on spot-like future-delivery contracts. As explained above with respect to ERI, this argument simply serves to decrease further the reliability of medium- and long-term price forecasts based on these econometric models.

International (NAC). RFI Comment of Fluor-B&W Portsmouth, Attachment A, NAC International, ''Impact of DOE Excess Uranium Sales on the U_3O_8 Market'' (April 2014) (hereinafter ''NAC Report'').[49] In its analysis, NAC based its production cost estimates on its Uranium Supply Analysis System (USAS). NAC updates this model each year based on a review of various published reports and presentations. NAC then applies cost models to derive specific cost estimates for individual properties. NAC Report, C–1. Specifically, NAC applies a discounted cash flow rate of return model based on both full cost (including sunk costs) and forward costs for each property. NAC Report, C–2 to C–3. NAC also utilized an estimate of reactor requirements and uncommitted demand developed from its Fuel-Trac database. NAC Report, D–1.

NAC developed a range of estimates of the impact of DOE transfers utilizing its production cost estimates at three different rates: 2,800 MTU per year, 2,400 MTU per year, and 10% of U.S. reactor requirements. NAC Report, 3–21 to 3–22. First, NAC applied a methodology it believes approximates ERI's approach to its own cost estimates. Specifically, NAC identified the incremental cost of the last property needed to meet demand in a given year based on total supply and demand. NAC Report, 3–22. NAC then explains that because long-term contracts with fixed pricing mechanisms have allowed some high-cost producers to produce ahead of lower cost supply, it believes a better approach is to base the model on uncommitted supply and demand. NAC then applies a multiplier to these estimates to account for additional incremental costs not included in its site forward production costs estimate. These additional costs include increased site forward costs due to operation at less than nominal capacity, taxes, corporate overhead, and variations in the required rate of return. NAC Report, 3–23. NAC also applies a time shift to the cost trend to account for the fact that producers need a price signal before investing in a new production center—*i.e.* producers need to have prices that justify an investment before actually making the investment. NAC Report, 3–24. The specific quantitative impact projected by NAC is summarized in Table 8.

TABLE 8—NAC ESTIMATES OF PRICE EFFECT OF DOE TRANSFERS ON URANIUM CONCENTRATE SPOT PRICE IN $ PER POUND U_3O_8 [51]

	NAC Report					
	Uncommitted supply demand			Uncommitted supply demand adjusted by [REDACTED] [50]		
	2400 MTU	2800 MTU	10% of US Req.	2400 MTU	2800 MTU	10% of US Req.
2014 2015 2016 2017 2018 2019 Average (2014–2018)	[REDACTED]					

DOE has considered NAC's forecast, but does not place much weight on these estimates for the reasons explained below. DOE notes that NAC estimates a price effect from DOE transfers that is much smaller than what other experts (including ERI) conclude. While, as noted above, an agreement between two similar models does not necessarily increase the credibility of either, a substantial difference like that between NAC's model and others creates some doubt. Some important input, either of data or of modeling assumption, must have caused the departure; the difference in predictions thus represents a disagreement between the modeler and other experts. That is not to say that NAC's model is necessarily incorrect. But in this context, where an error would mean substantially misestimating the potential impact of DOE's transfers, DOE would only rely on the estimate if the difference from other forecasts were well understood and justified.

In addition, DOE does not agree that it is appropriate to focus on uncommitted supply and uncommitted demand, as opposed to total supply and demand, in the manner described by NAC. Entities other than primary producers and reactor owners/operators participated in the uranium concentrates market. NAC's estimate of uncommitted supply and demand appears not to incorporate these other participants. *See* NAC Report, 3–20.[52] Given this uncertainty, DOE does not believe relying on NAC's conclusions would be justified.

d. UxC Report

Cameco Corp. attached to its comment in response to the RFI a market analysis it commissioned from UxC, another uranium market consultant. RFI Comment of Cameco Corp., Attachment, UxC Special Report, ''Impact of DOE Inventory Sales on the Nuclear Fuel Markets'' (January 2015) (hereinafter ''UxC Report''). A summary of UxC's

[49] As this report was prepared in April 2014, it does not contain updated information on developments in the markets since that time. The level of uranium transfers that it analyzes is based on the levels specified in the May 2012 Secretarial Determination, which is roughly similar to, though slightly higher than, the current rate of transfers. NAC Report, A–1 to A–3.

Some commenters expressed concern that DOE's 2014 Determination relied on information from Fluor-B&W that was outdated and that, because Fluor-B&W is not a regular participant in uranium markets, warranted no reliance. DOE recognizes that the NAC Report is based on data that are now more than one year old. DOE's analysis relies on information from myriad sources, described throughout, and uses the data currently available. Data from EIA and other sources may lag the market by as much as several months, but given the rate at which these markets change, it is appropriate to rely on data after such a limited delay.

[50] Note that NAC states that it believes it is appropriate to apply a multiplier [REDACTED]. *See* NAC Report, 3–22 to 3–24.

[51] NAC also provides estimates based on Total Supply and Demand at Table 3.4. NAC Report, 3–22. Given that the report states that NAC believes this approach is inaccurate, these estimates are not reproduced in this table.

[52] NAC explains that its estimate of uncommitted demand consists of uncommitted utility demand plus supplier delivery commitments in excess of estimated production capability. This second aspect may refer to some of the demand created by brokers and traders. However, it is not clear whether this includes strategic or discretionary purchases by utilities or other entities.

estimates of the effect of DOE transfers on future prices appears in Table 9. UxC explains that it estimated the price effect of DOE transfers using two proprietary econometric models: The U–PRICE model and the SWU–PRICE model. UxC explains that these models were developed using historical data on the nuclear fuel markets collected and compiled by UxC. These two models take into account and quantify the impact of ''key factors influencing the markets.'' UxC also explains that the two models can be linked to simulate the interrelationship between uranium concentrates and enrichment. UxC Report, 3.

Using these two models, UxC estimates the effects of DOE transfers on prices during the period between 2012 and 2014. UxC provides two estimates. It derived the first, which it labels the ''incremental approach,'' by running its models from 2011 onwards, with and without DOE transfers. It prepared the second, which it calls the ''total impact approach,'' by running its models from 2008 onwards. UxC's models generally ascribe to DOE's transfers an accumulating effect on price, because, according to UxC, past transfers ''have a longer-term effect on market perceptions among both buyers and sellers.'' UxC Report, 5. Thus, by running its models from 2008 onwards, UxC produces 2012 estimates that reflect cumulative effects it ascribes to transfers between 2008 and 2011. UxC's ''incremental'' estimate is that between 2012 and 2014 DOE's transfer reduced the spot price by an average of $4.50 per pound and the term price by an average of $2.88 per pound. UxC's ''total impact'' estimate is that between 2008 and 2014 DOE's transfers reduced the spot price by an average of $7.11 per pound and the term price by an average of $5.10 per pound. UxC Report, 6–7.

UxC also forecasts the effect of continued DOE transfers at current rates for the period 2015 to 2030. UxC predicts that such transfers in the near and medium terms would reduce the spot price by an average of $5.78 per pound. UxC projects that this effect will change slightly in the medium term as market prices start to recover. Specifically, DOE transfers (at current rates) would reduce the spot price between 2018 and 2030 by an average of $4.47 per pound. UxC also notes that the former number is larger relative to the expected price of uranium than the latter number (14.1% versus 7.1%). UxC Report, 10. UxC forecasts that DOE transfers (at current rates) in the near and medium terms would reduce the term price by an average of $4.86 per pound. Between 2018 and 2030, DOE transfers are predicted to reduce the term price by an average of $5.30 per pound. Again, the near and medium term impact is larger in relation to the expected price (9.0% versus 7.1%). UxC Report, 11.

TABLE 9—UXC'S ESTIMATE OF EFFECT OF DOE TRANSFERS ON URANIUM CONCENTRATE SPOT AND TERM PRICES IN $ PER POUND U_3O_8

	UxC Report			
	Near- & mid-term price effect	Percent of expected price	Long-term price effect	Percent of expected price
Spot Price	$5.78	14.1%	$4.47	7.1%
Term Price	4.86	9.0%	5.30	7.1%

UxC puts particular emphasis on the interrelationship between the uranium and enrichment markets. UxC states that uranium and SWU are ''substitutes.'' Thus, UxC uses enrichment prices as an input into its uranium concentrate price forecast, and vice versa. UxC Report, 5, 8, 17. As described in Section II.A.5, DOE understands that this interplay can take several forms. First, to the extent that enrichers have unsold enrichment capacity, they may apply that excess capacity to underfeeding and/or re-enriching DUF_6 tails. This essentially allows enrichers to generate additional natural uranium hexafluoride, which could then be sold on the open market. Second, if the price of enrichment decreases relative to the price of uranium concentrates, the optimum tails assay decreases, so that customers may deliver less natural uranium feed to get the same amount of enriched uranium output.

The other market analyses do not appear to take these interactions into account.[53] DOE has carefully considered UxC's analysis. However, DOE does not believe UxC's consideration of the above-referenced interactions is a reason to place greater weight on UxC's modeling for the following reasons. Among other things, the contribution of enrichment price changes to the uranium price, in the conditions relevant here, is quite small, even compared to the effect of DOE's transfers, particularly in the short term. Assuming an enriched product assay of 4.5% and a tails assay of around 0.25%, applying one SWU of additional enrichment can generate roughly one kilogram of additional natural uranium. Thus, if the price for one SWU decreases by 4% and the price for one kilogram of uranium decreases by 7%, as UxC forecasts to be the average effect of continued transfers at current rates, the comparative value of using spare capacity to provide enrichment or for underfeeding would change by only 3%. ERI forecasts that underfeeding will supply about 8 million kg of natural uranium per year in the medium term, about 11–12% of predicted world requirements. Changing that supply by 3% would mean a change of about 200 MTU, much less than the 2,705 MTU of DOE transfers that UxC assumed.

Furthermore, UxC's forecast for the price effect attributed to DOE transfers in coming years is substantially higher than what any of the other reports predict. That difference may be a reason to scrutinize UxC's predictions. In addition, aspects of UxC's models, as explained below, appear to make them less reliable in this regard, especially for the task of attributing price effects to a discrete element of supply, specifically DOE's transfers. UxC uses several exogenous variables to account for subjective, unquantifiable phenomena such as ''market participants' general perception of the industry outlook'' and ''changes in market psychology.'' These exogenous variables appear to play key

[53] ERI's market clearing price analysis, for example, includes material from underfeeding as ''Secondary Supply.'' However, ERI does not consider how a change in uranium concentrate and/or conversion prices would affect the price of SWU or the level of underfeeding present in secondary supply. In effect, ERI assumes that secondary supply based on enrichment services has a marginal cost lower than any primary producer in the market, so that this source would contribute the same amount of supply at any price level among those likely to be attained. TradeTech's and NAC's reports do not mention accounting for enrichment-based secondary supply.

roles at certain steps in the models. UxC assigns values for the variables prior to running its model in order to define the scenario that the model will forecast. Thus, the outputs depend in part on UxC's subjective decisions about input factors such as ''market sentiment.'' Perhaps that characteristic does not impair UxC's ability to forecast prices in the near future, because it might be possible to choose appropriate values for these variables by finding those for which the model best reproduces the recent past. But to assign a price change to DOE's transfers, UxC necessarily ran its models with counterfactual scenarios, namely the markets without DOE transfers, and it made different assumptions about future markets. While UxC has not said whether it used the same values for its exogenous variables in running the model with and without DOE transfers, DOE must presume it used different values because the report stresses that DOE's transfers have a long-term effect on ''market perceptions,'' the type of unquantifiable factor the variables are meant to represent. For all these reasons, DOE concludes that a model reliant on subjective exogenous variables is likely to be less reliable than those used by the other reports.

e. Effect of DOE transfers on market price

In light of these market analyses and its review of them, DOE concludes that transfers under the assessed case will continue to exert some downward pressure on the market price for uranium concentrates. DOE believes $2.70 per pound is a reasonable estimate of how much downward price pressure transfers under the assessed case will contribute on average over the next decade. In 2016 and 2017, the price impact will be even lower, between $2.10 and $2.20 according to ERI's market clearing analysis, and approximately $1.90–$2.00 according to ERI and TradeTech's econometric forecasts. To be cautious, DOE will base its analysis on the full amount of $2.70.[54]

The significance of price suppression at this level depends, at least in part, on market price. Recent spot and term price indicators published by UxC on March 30, 2015, were $39.50 per pound U_3O_8 on the spot market and $49.00 per pound U_3O_8 on the term market. The forecast price effect reasonably attributable to DOE transfers represents 6.8% and 5.5% of these values, respectively. But comparing future price changes to current prices provides at most a sense of scale. DOE believes it is more appropriate to compare the price effect in future years to forecasted market prices in those years.

Several sources generally predict an increase in market prices over the next several years. ERI notes that term prices are expected to increase in the future, but does not provide a specific forecast. 2015 ERI Report, 46. ERI's econometric model, however, does show an increase in the spot price. Specifically, ERI forecasts that spot prices will recover over the course of 2015–2018 eventually settling in the $52–57 range after 2019. 2015 ERI Report, 52. TradeTech's Exchange Value spot-price forecast increases to approximately $50 as early as June 2016, even with DOE transfers. TradeTech Report, 20. UxC's estimates of the effect of DOE transfers assume that market conditions will improve in the medium term. [REDACTED]. Figures 5 & 6, UxC Report, 11. In its annual Uranium Market Outlook, UxC provides a more detailed explanation of its price forecast, which generally predicts an increase in price over the next 10 years. UxC Uranium Market Outlook—Q4 2014, 111–19 (2014). [REDACTED]. *Id.* at 119.[55]

Using these price forecasts, it is possible to project the estimated price effect in future years as a percentage of the expected market price. ERI's market clearing price model predicts that the price effect will remain relatively stable over the next years. As prices increase, this price effect will represent a smaller proportion of the then-prevailing market prices. As spot prices increase above $50, which DOE expects will happen by 2019 or 2020, the long-term price effect attributable to DOE transfers would represent approximately 5.4% of the spot price.

f. Effect on realized prices

A principal mechanism through which a change in market price could impact the domestic uranium mining industry is through the effect on the prices that various production companies actually receive for the uranium they sell—the ''realized price.'' The market prices published by TradeTech and UxC are based on information about recent offers, bids, and transactions. Thus, the market price is a snapshot of contracting activity at the time of the publication. It includes activity that does not involve the domestic uranium producers—*i.e.* transactions involving international producers, traders, and brokers. In addition, the current market prices do not reflect the fact that many uranium producers actually achieve prices well above the market prices due to the prevalence of long-term contracts that lock in pricing terms over a period of several years.

Most deliveries of uranium concentrates take place under term contracts. According to contracting data published by UxC, utilities made spot purchases of [REDACTED].[56] UxC Uranium Market Outlook—Q4 2014, 27 (2014). UxC projects that spot purchases in 2015 and 2016 [REDACTED]. *Id.* at 63.[57] These figures indicate that utilities met approximately [REDACTED] of their requirements in 2014 through contracts greater than one year in duration.[58]

It is also significant that long-term contracting volume has not been uniform in recent years. [REDACTED].[59] [REDACTED]. *Id.* at 29. [REDACTED]. *Id.* at 28, 61, 66. [REDACTED]. *Id.* at 28. Based on this information, DOE notes that the vast majority of current term contracts were entered into when market prices were significantly higher,

[54] Two commenters contended that DOE's forecast of the price effect is implausibly low because, they said, the spot price has in the past changed by almost $6 per pound in response to volume changes less than 2% of DOE's transfers. DOE notes that 2% of DOE's transfers would amount to around 54 MTU per year. It seems highly unlikely that a change in supply by 54 MTU per year would cause a price change of $6 per pound, and the commenters cited no specific examples.

[55] Commenters describe a variety of different market effects that will affect market prices in future years, including currency exchange rates, changes in demand due to Fukushima, high near-term production. UxC's appears to take these various factors into account in developing its price projections. Given these considerations, and given that UxC's projections of prices are in general agreement with the other models, DOE has noted UxC's price projections in the above discussion, although, for the reasons discussed above, DOE does not take the same view with respect to UxC's forecast of the price effect attributable to DOE transfers. Forecasts of the overall trend of prices ultimately reflect predictions about total requirements and total supply, which are less susceptible to some of the uncertainties that arise for the econometric models discussed in this analysis.

[56] As this figure was published in December 2014, it does not include contracting activity for the balance of 2014. UxC projects that spot purchases by utilities in the remainder of [REDACTED]. UxC Uranium Market Outlook—Q4 2014, 63 (2014).

[57] UxC also reports that purchases by traders, brokers, and entities other than utilities [REDACTED]. UxC Uranium Market Outlook—Q4 2014, 27 (2014). UxC projects that purchases by non-utilities [REDACTED]. *Id.* at 63.

[58] EIA defines the spot market to include contracts for delivery in less than one year. UxC appears to use the same definition.

[59] This figure refers to the aggregate volume purchased under all term contracts entered into during each year. However, actual deliveries would not take place for several years. For example, a hypothetical term contract entered into in 2010 might provide for a specified amount of U_3O_8—say 200,000 pounds—to be delivered in each year beginning in in 2012 and ending in 2019. The number included in the 2010 total volume figure for this contract would be 1.6 million pounds.

i.e. when term prices were above $60.00.

These observations are particularly significant because uranium prices have declined in recent years and only recently began to recover. In 2014, the spot price reached a low of $28.25, after decreasing from a high of $136.00 in 2007. Compared to the low of $28.25, a price effect from DOE transfers of $2.70 per pound would represent 9.6%. However, the actual effect experienced by a primary producer would be the proportionate change in its realized prices. As mentioned above, several of the market analyses that DOE reviewed forecast that prices will be increasing substantially in the next few years and should reach $50 by 2019 or 2020. Consistent with those forecasts, spot prices are currently 16–20% higher than they were one year ago. Because the low prices of 2013–2014 were only temporary, realized prices for most producers can be expected to be more in line with the longer-term trend of prices. Consequently, the price effect of DOE's transfers should be regarded in comparison to the longer-term trend rather than to the recent past of especially low prices. Furthermore, based on current trends in term contracting, there will be relatively few new term contracts entered into on the basis of current prices and they will likely have a shorter average duration than in years past. Thus, although the price effect attributable to DOE transfers in the term market would have an effect that would persist through the life of any new term contracts, this effect is likely to be limited in the near term.

ERI estimates the prices realized by U.S. producers by gathering information from public filings representing approximately 95% of U.S. production. 2015 ERI Report, 60–61. Realized prices declined for most primary producers in 2014, an outcome that presumably reflects the fact that market prices had, by 2014, been declining continually for several years. 2015 ERI Report, 61. Still, ERI estimates that several producers achieved realized prices in 2014 well above the average spot price over the course of the year. At least one producer achieved a realized price well above the average term price for 2014. 2015 ERI Report, 61.

ERI reports that some mining companies have negotiated contracts that base the price paid at least partially on a fixed or base-escalated pricing mechanism. As an example, Cameco has reported that the price sensitivity of its current contract portfolio is about 50% of any change in spot market price. ERI estimates that less than 30% of U.S. production currently comes from companies that are effectively unhedged against changes in spot price. 2015 ERI Report, 60–61.

TradeTech also provides its estimates of the decline in realized price for several producers—both U.S. and foreign. Although TradeTech does not provide specific figures, it provides information on several firms in chart form. It appears from the chart that among the firms for which TradeTech provides estimates, realized prices in 2013 varied from as low as about $38 to as high as about $57. For most producers, there was a decline in realized price between 2011 and 2013. The magnitude of that decline ranges from approximately $12 to as low as $2 or $3. TradeTech Report, 13. TradeTech notes that one reason for declining realized prices is the expiration of long-term contracts signed when prices were substantially higher. TradeTech Report, 12.

NAC similarly notes that some higher cost suppliers have locked in higher prices through fixed price contracts that allow them to realize prices greater than current market prices. NAC Report, 3–22. Although NAC estimates the effect of DOE transfers on market price, as described above, NAC does not provide specific estimates of the effect on the price realized by individual producers.

EIA reports several figures that are relevant to the prices realized by current producers. EIA reports that the weighted average price in sales directly from U.S. producers in 2013 was $44.65. EIA, 2013 Uranium Production Report, 7 (2014). Similarly, EIA reports that the weighted average price paid by U.S. reactor operators in 2013 was $51.99 per pound U_3O_8 equivalent. *Id.* at 4. Although EIA does not provide a complete range of prices paid by U.S. reactor operators, it does report that the bottom 7.1 million pounds U_3O_8 equivalent (approximately ⅛th of uranium delivered in 2013) purchased by U.S. operators had a weighted average price of $34.34. The top 7.1 million pounds had a weighted average price of $72.62.[60] *Id.* at 26. EIA also provides average prices broken down by origin—foreign vs. U.S.—and by seller—U.S. producer, U.S. brokers and traders, other U.S. suppliers (*i.e.* other reactor operators, converters, enrichers, or fabricators), and foreign suppliers. The weighted average price in 2013 for U.S. origin uranium was $56.37 per pound U_3O_8. The weighted average price in 2013 from U.S. brokers and traders was $50.44. For 2013, EIA does not report the weighted average price of uranium purchased by U.S. reactor operators directly from U.S. producers to avoid disclosure of individual company data. However, in recent years when that value is reported, it has been above the average price paid for U.S. origin uranium. *Id.* at 4. For comparison, DOE notes that the 2013 average spot price was around $39.00 and the average term price was around $54.00.[61]

EIA provides data about sales using different pricing mechanisms. EIA reports that of the approximately 23.3 million pounds U_3O_8 equivalent purchased by U.S. reactor operators from domestic sources[62] and delivered in 2013, 14.5 million pounds were purchased based on fixed or base-escalated pricing—approximately 62.3%—with a weighted-average price of $54.95. Approximately 3.6 million pounds were purchased based purely on spot-market pricing—approximately 15.6%—with a weighted-average price of $42.55. The remaining 5.1 million pounds—approximately 22%—was sold based on some other pricing mechanism with a weighted average price of $52.68. EIA, Uranium Marketing Report, 24 (2014).

Many companies report their realized prices in public filings. Based on average market prices over the time-frame these filings cover, this information can be used to infer the extent to which each firm is exposed to market price fluctuations. DOE has reviewed public filings with the SEC and other public financial information for several U.S. producers. This information is summarized in Table 10. Based on this information, it appears that only two producers sell U_3O_8 exclusively at the spot price. Although ERI estimates that less than 30% of U.S. producers are currently unhedged against changes in the spot price, data from public filings, many of which were released after publication of the 2015 ERI Report, indicate that producers selling exclusively at the spot price represented less than 15% of reported production in 2014.

[60] These two figures do not differentiate between U.S.-origin versus foreign material. However, EIA reports that the weighted average price of U.S. origin material is higher than the average for all foreign material. EIA, 2013 Uranium Marketing Report, 20 (2014).

[61] As calculated according to monthly price indicator data from UxC.

[62] Note that EIA's figure includes purchases of U.S.-origin uranium as well as purchases from a firm located in the United States. Therefore, this number includes uranium from sources other than the domestic uranium industry. EIA reports that approximately 9.5 million pounds of U.S. origin uranium was delivered to U.S. reactor operators in 2013. EIA, Uranium Marketing Report, 20 (2014).

TABLE 10—REPORTED SALES AND REALIZED PRICE BY U.S. PRODUCERS [69]

Information from public filings		
Producer	2014 Sales (lbs U_3O_8)	Realized price
Uranium One [63]	410,800	$32
Ur-Energy [64]	90,000	55
Cameco [65]	2,700,000	48
Uranerz [66]	175,000	57
Energy Fuels [67]	800,000	57
Uranium Energy Corp [68]	N/A	N/A

Contracting decisions are specific to the buyer and the particulars related to these decisions are not routinely made public. However, from the information that is available, DOE notes the following key points related to the effect of DOE transfers on realized prices in the domestic uranium mining industry. Most high cost suppliers hold fixed price contracts that allow them to realize prices significantly greater than current market prices. These fixed price contracts insulate the producers from changes in market price and tend to dampen the short-run effect of DOE transfers. To be sure, new long-term contracts expected to be signed in the next few years, would reflect any continued suppression of market prices resulting from DOE transfers. However, as mentioned above, term contract activity is expected to remain low in the near term. In addition, prices have already increased from recent lows and are expected to increase substantially in the next few years. Given that the vast majority of uranium is purchased from producers under term contracts,[70] DOE believes the effect on future term contracts will be small compared to the effect on existing contractual deliveries.

In light of all these factors, DOE concludes that the anticipated effect of its transfers on market prices will tend to overstate the effect on the domestic uranium mining industry in terms of actual realized price. Although public filings suggest that only 15% of producers are unhedged against fluctuations in the spot price, DOE will conservatively assume that 30% of the industry is not insulated from these fluctuations due to preexisting long-term contracts as ERI suggests. Further assuming that this insulation is equivalent to 50% exposure to the changes in market price, the average price effect on the domestic uranium industry's realized prices in the near term would be closer to $1.75. DOE notes that this price effect is relatively small when compared to the market prices forecasted for the next several years—between 3.5% and 4.5% of expected spot market prices. That said, consideration of the effect on realized prices on its own is not sufficient to determine whether the impacts will be material. The implications of transfers for the factors discussed in the next four sections have also been considered.

2. Production at Existing Facilities

DOE believes that primary producers consider a range of different inputs in determining whether to decrease, continue, or increase production at currently operating facilities. Market prices are certainly one element of this calculation, but producers also consider contractual obligations (and what these contracts may mean for realized prices), projections about future prices, and the various costs associated with changing production levels. In order to forecast how DOE transfers will affect production levels, DOE has considered how producers have responded to price changes in the past. Some of the primary inputs in these decisions are the relationship between market prices and production costs, and expectations about future price trends.

EIA reports data on production levels in the domestic uranium industry on a quarterly and annual basis. EIA's most recent quarterly report provides preliminary data for 2014. U.S. primary production in 2014 stood at 4.9 million pounds U_3O_8. This is about 5% higher than in 2013 and 15% higher than in 2012. In fact, this represents the highest production total in any calendar year since 1997. EIA, Domestic Uranium Production Report Q4 2014, 2 (January 2015). ERI also notes that U.S. production has risen since the recent program of DOE uranium transfers began in December 2009. In 2014, production was 5% higher compared to the previous year. However, ERI reports that production in 2015 is expected to decline to 2013 levels. 2015 ERI Report, 58.

Since 2009, four new operations have begun production in the United States: Willow Creek in 2010, Hobson/Palangana in late 2010/early 2011, Lost Creek in 2013, and Nichols Ranch in 2014. ERI also reports that one

[63] These figures represent sales only through Sept. 30, 2014. Uranium One operates the Willow Creek mine in Wyoming. Uranium One Inc., Management's Discussion and Analysis, Quarter Ending September 30, 2014, at 2, 17 (Nov. 14, 2014), *http://www.uranium1.com/index.php/en/component/docman/doc_download/926-q3-2014-managements-discussion-a-analysis.*

[64] UR-Energy operates the Lost Creek ISR mine in Wyoming. UR-Energy Inc. Form 10–K, Securities and Exchange Commission, at 50 (Mar. 2, 2015) *https://www.sec.gov/Archives/edgar/data/1375205/000155837015000251/urg-20141231x10k.htm* (accessed Mar. 27, 2015).

[65] Cameco operates the Smith Ranch-Highland (Wyoming) and Crow Butte (Nebraska) ISR mines. Cameco, Management's Discussion and Analysis, Quarter Ending December 31, 2014, at 40, 69–70 (Feb. 9, 2015), *http://s3-us-west-2.amazonaws.com/assets-us-west-2/quarterly/CCO_2014_Q4_MDA_and_Financial_Statements.pdf.*

[66] Uranerz Energy Corp., which operates the Nichols Ranch ISR mine in Wyoming, reports that it sold 175,000 pounds of uranium oxide in 2014 for a revenue of $10,006,673. Uranerz Energy Corp. Form 10–K, Securities and Exchange Commission, at 50 (Mar. 16, 2015) *https://www.sec.gov/Archives/edgar/data/1162324/000106299315001350/form10k.htm* (accessed Mar. 27, 2015).

[67] Energy Fuels, which operates the White Mesa conventional mill in Utah, reports that its realized price in 2014 averaged $57.19. Energy Fuels Inc., Management's Discussion and Analysis, Year Ending December 31, 2014, at 4 (Mar. 18, 2015), *https://www.sec.gov/Archives/edgar/data/1385849/000106299315001408/exhibit99-2.htm.*

[68] Uranium Energy Corp. (UEC) operates the Hobson/Palanga ISR mine in Texas. UEC reports that it had no sales during the fiscal year ending July 31, 2014, although it continued to produce uranium concentrates. UEC states that future uranium concentrates sale are expected to occur at the spot price. Uranium Energy Corp. Form 10–K, Securities and Exchange Commission, at 72 (Oct. 10, 2014) *https://www.sec.gov/Archives/edgar/data/1334933/000106299314005923/form10k.htm* (accessed Mar. 27, 2015).

[69] In addition to the companies listed in text, DOE's EIA also reports one additional operating mine at the end of Q4 2014: Alta Mesa in Texas. The parent company for this mine, Mestena Uranium LLC, is closely held and publishes little information publically. UxC reports [REDACTED]. UxC Uranium Suppliers Annual—December 2014, 225–26 (2014).

[70] For example in 2014—[REDACTED]—producers worldwide contracted to deliver [REDACTED] through term contracts, but only [REDACTED] on the spot market. UxC Uranium Market Outlook—Q4 2014, 126–127 (2014). In 2012, [REDACTED], producers contracted to deliver approximately [REDACTED] through term contracts, but only [REDACTED] on the spot market. *Id.*

additional production center is expected to begin operations in 2015. Despite these new operations, ERI notes that several conventional and in-situ leach operations have scaled back operations. 2015 ERI Report, 57. EIA reports that the same number of uranium concentrate processing facilities—seven—operated in 2014 as in 2013. Specifically, while the Nichols Ranch ISR plant began operation in the second quarter of 2014, the White Mesa conventional mill halted production in the fourth quarter of 2014. EIA Domestic Uranium Production Report Q4 2014, 3–6 (January 2015).

ERI presents a chart showing the price levels at the time cutbacks were announced at various U.S. suppliers. ERI reports price points for cutbacks at four operations: $45 per pound in the spot market for conventional mines in Utah; $40 per pound in the spot market for two in-situ-leach operations; and $35 per pound in the spot market for additional conventional mines and a uranium mill. 2015 ERI Report, 62.

ERI then estimates average production costs for existing mines by referring to EIA's published data on production expenditures across the uranium industry. Using a three year average to smooth out year-to-year differences, ERI notes that average production costs have remained fairly constant since 2009 at about $40 per pound. 2015 ERI Report, 63. ERI further reports that it estimates production costs at U.S. in-situ-leach facilities to range from the low $30s to the mid $40s per pound. ERI concludes that the pattern of cutbacks and estimated production costs ''do not seem to indicate that adding back the $3 per pound price effect attributed to all DOE inventory material for Scenario 1 would move current prices enough to cause U.S. producers to ramp well field development and production activities back up.'' 2015 ERI Report, 64. ERI further notes that the spot price would remain near $40 per pound and ''may still not be sufficient for higher cost ISL producers to restart well field development or higher cost conventional mines to resume mining activities, and likely would not have prevented the decisions to cut back when prices declined to $35/lb in mid 2013 and then below $30/lb in mid 2014.'' 2015 ERI Report, 64.

The UxC Report does not provide any specific estimates of production levels or costs at currently operating facilities. However, UxC has developed production cost data elsewhere in its annual report on uranium suppliers and a 2013 production cost study. UxC Uranium Suppliers Annual—December 2014 (2014); UxC Uranium Production Cost Study (2013). [REDACTED].[71]

The TradeTech Report predicts a ''potential reduction in the number of market participants.'' TradeTech Report, 21. It applies the price effect it estimates for DOE transfers to a hypothetical uranium producer with a production cost of $47.41 per pound. See Figure 15 of TradeTech Report, 22. TradeTech does not apply its estimate to any particular producer. TradeTech does, however, provide estimates for the production costs of several firms in both 2011 and 2013.[72] Although TradeTech does not provide numerical cost data, it does provide information on several firms in chart form. It appears from the chart that among the firms TradeTech provides estimates for, production costs in 2013 varied from as low as $30 to as high as $50. TradeTech also notes that many producers have been able to reduce or stabilize costs in recent years. This is also reflected in the difference between the producers' costs in 2011 and in 2013. TradeTech Report, 13.

NAC provides estimated production cost ranges for segments of current supply, but it does not directly estimate the effect of DOE transfers on production levels. NAC Report, 3–9 to 3–11. Specifically, NAC provides a chart showing the breakdown of worldwide operating production capacity [REDACTED]. NAC Report, 3–10. DOE notes that this chart does not provide separate estimates of production from U.S. facilities, although NAC does state that [REDACTED]. NAC Report, 3–11.

A commenter noted that production in the recent past is not an accurate indicator of how DOE's transfers affect the mining industry, because current production reflects conditions of three or four years ago when the investment decisions were made. This commenter suggested that exploration data would be a better guide for assessing how industry is responding to current conditions. In addition, the commenter submitted information it received from Cameco indicating that production at Cameco's two main areas will decline from 2.7 million pounds in 2014 to 1.7 million pounds in 2015. This information is generally consistent with the data provided by the various reports summarized above.

DOE recognizes that large-scale changes in production can take several years, and for that reason among others it does not base its analysis simply on the fact that current production is comparable to 2013 production. At the same time, DOE notes that declines in production in 2015 are not, in their entirety, reasonably attributable to DOE's transfers. According to the commenter, the effect of market conditions takes three to four years to be fully manifest in production levels. If so, then a decline in production in 2015 would presumably result primarily from the large-scale market changes in the second half of 2011 and then in 2012 as a result of the Fukushima disaster. To forecast the effects reasonably attributable to DOE's transfers, a more careful analysis like that described below is more appropriate.

As actual production levels and costs are usually proprietary information, DOE must generally rely on estimates. The production cost estimates from TradeTech, NAC, and UxC are all generally consistent with ERI's conclusions. Each market analysis describes production costs falling within a similar range.

As noted above, based on the current spot price of $39.50[73] and ERI's estimates of the price effect of DOE transfers, removing DOE-sourced material from the market altogether—including material already transferred in the past as well as the material to be transferred under the assessed case—could lead to spot prices around $42.50 and DOE transfers under the assessed case could lead to market prices between $39.70 and $40.10. Although UxC estimates [REDACTED].

To summarize, it does not appear that the price effect of DOE transfers would cause realized prices to be below production costs at any particular facility. DOE recognizes that receiving prices barely above production costs would not provide enough return to justify investing in production, and a producer needs to receive a certain amount of margin. The TradeTech Report suggests 10% is an appropriate margin. But elevating the threshold for these mines from production cost to production cost plus 10% would not alter the conclusions discussed above.[74]

[71] Information from this paragraph is collected from the two UxC studies mentioned above. The price bands come from UxC Uranium Production Cost Study, 80–84 (2013), and cost estimates in parentheses comes from UxC Uranium Suppliers Annual—December 2014 (2014) (except for data on [REDACTED] which comes from UxC Uranium Production Cost Study, 111–12 (2013).

[72] This figure includes information on some projects that are not part of the domestic uranium mining industry, such as Uranium One's Kazakh projects.

[73] UxC's monthly spot price as of March 30, 2015.

[74] One commenter suggests that DOE calculate the effect of its transfers on average margins, which it claims would be a straightforward calculation. The commenter cites as an example a hypothetical model included in the TradeTech report. In DOE's view, the TradeTech hypothetical, as discussed below, seems to bear little relation to any actual

Accordingly, DOE concludes that ceasing transfers entirely—which could cause prices to increase by up to $2.70 per pound—would not cause U.S. producers to increase production levels substantially in the near term.

The estimates in the preceding paragraph are based on a comparison of expected realized prices of specific mines and estimates of production cost at those mines. However, DOE notes that this is a somewhat oversimplified comparison. Decisions regarding whether to increase or decrease production are based on a number of considerations, of which the instantaneous market price is only one. Recent production data provides some evidence that market prices are not the sole consideration. Despite the fact that market prices were at their lowest levels in recent memory, EIA's most recent quarterly report states that U.S. primary production in 2014 was higher than in any calendar year since 1997. Even while production ceased at some facilities, production began for the first time at others. Meanwhile, producers with production costs above the average spot price in recent years have continued operations. One of those considerations is included in the above discussion, namely the difference between realized price and market price. In addition, DOE believes that this behavior is related to the significant cost and time lag involved in ceasing or slowing production at an existing facility. Due to these facts, DOE believes that production decisions are likely to be based on future expectations about market prices and contracting trends in addition to current market prices.

Given that removing the price effect associated with DOE transfers is not likely to be enough to materially change the relationship between price and cost for any particular producer and that production decisions are based on additional considerations that include future expectations about market prices and contracting trends, DOE agrees with ERI's conclusion that adding back the price effect of DOE transfers would not move current prices enough to cause U.S. producers to increase production at existing facilities.

Some commenters objected that this conclusion is irrelevant. However, it is an appropriate implementation of the analytical approach discussed above, in which DOE assesses the impact reasonably attributable to its transfers. To do so, DOE compares the likely state of affairs with transfers and without DOE transfers. The conclusion that continuing transfers under the assessed case would not result in U.S. production's being markedly lower than it would in the absence of DOE transfers constitutes such a comparison.

3. Employment Levels in the Industry

DOE has considered information from EIA reports relating to employment in the domestic uranium production industry. EIA's most recent Uranium Production Report states that employment stood at 1,156 person-years in 2013, 1,196 person-years in 2012, and 1,191 person-years in 2011. EIA, 2013 Uranium Production Report, 10 (May 2014).

In its analysis, ERI compared EIA's employment figures with changes in uranium spot and term prices. Based on a statistical correlation, ERI infers that employment responds to changes in price. 2015 ERI Report, 73. ERI then uses this correlation to estimate that the decrease in uranium prices over the course of 2014 resulted in a loss of 114 person-years from the 2013 value of 1,156. 2015 ERI Report, 55. ERI then estimates that the price effect it attributes to DOE transfers lowered employment by 41 person years in 2013, and 44 person years in 2014. 2015 ERI Report, 56. ERI further estimates that price effects due to DOE transfers at the levels described in Scenario 1 would result in an average employment loss of 42 person years over the next 10 years. For Scenario 2 and 3, ERI estimated that the average employment loss would be 39 and 21 person years, respectively. Again, it is important to note that this estimate is not a prediction that the uranium production industry under Scenario 1 would shed 42 jobs in 2015 and each subsequent year. Instead, this figure reflects ERI's estimate that total employment in the industry would be higher by an average of 42 person-years without DOE transfers compared to with DOE transfers.

Several commenters asserted that employment has decreased in recent years as a consequence of decreases in uranium prices. *E.g.,* RFI Comment of Mark S. Pelizza, at 1. Some commenters stated that the uranium production industry has lost half its workforce since May 2012. RFI Comment of UPA, at 2; RFI Comment of Uranerz, at 2.

Several uranium producers provided data regarding their employment. The combined figures from several producers come to employment of 845 in 2012 and 424 in 2014. NIPC Comment of UPA, at 7–8.

DOE nonetheless does not believe that employment in the uranium mining industry has decreased by half since May 2012. That claim runs contrary to reporting by EIA that employment was 1,191 in 2011, 1,196 in 2012, and 1,156 in 2013. EIA, 2013 Uranium Production Report, 10 (May 2014). This is only a 3% decline between 2011 and 2013. Although EIA has not yet reported uranium employment in 2014, DOE notes that production levels in 2014 were very close to levels in 2013 and that one new facility began operation in 2014. Thus it seems reasonable to assume that employment levels were similar as well. EIA Domestic Uranium Production Report Q4 2014, 3–6 (January 2015).

DOE believes the EIA reports on uranium-industry employment are more reliable than the commenter's submission on this point. In general, the EIA collects its data through a survey, responses to which are mandatory. The survey terms are well defined and, with respect to employment, should capture the relevant employment. By contrast, the commenter describes its data as counting ''current employment activities.'' It is not clear which employees are included in the count or whether the inclusion criteria are even uniform across companies. More significantly, the commenter's submission does not encompass the whole domestic industry. A number of the companies represented did decrease production, but the commenter's figures appear not to include some mines that have increased production.

Even if industry employment had decreased by half since 2012, for predicting the effect of DOE's transfers in the assessed case it is important to understand what portion of recent employment decreases is reasonably attributable to past transfers. No commenter attempted such an estimation. While it is difficult to infer causal connections between employment and any particular market phenomenon, DOE thinks it is likely that most if not all of the reduction in employment in the mining industry since 2011 can reasonably be attributed to the downturn in the demand for uranium, primarily due to the Fukushima events.

DOE believes that ERI's method for attributing an employment effect to DOE transfers is reasonable. ERI's method is based on an empirical observation that prices (particularly the two-year moving average of price) have been strongly correlated with employment over the last decade. This correlation exists despite the remarkable fluctuations in market conditions that have taken place

mine. To calculate margins, DOE would need to know actual realized prices, linked to production costs, on a mine-by-mine basis. Absent such details, DOE believes the estimation method described above is a sufficiently robust approach to forecasting the effect on production reasonably attributable to DOE's transfers.

in that period. The relatively small price effects likely to result from DOE's transfers—even the price effects that UxC forecasts—are much smaller than the variations of the past decade. Therefore, the correlation ERI observes should hold true for these small price effects. In addition, it is reasonable to expect that prices and employment will continue to correlate in such a way, because the correlation reflects persistent market phenomena. DOE expects that a producer increases or decreases employment in order to increase or decrease production, and it does so in response to increases or decreases in the price it will receive. For any given producer the relationship between employment and price will depend on multiple factors such as the producer's cost of production and its cost structure (*e.g.* what proportion of cost depends on employee numbers) and the producer's sales structure and realized prices. Aggregated over producers, the result would be the sort of correlation between prices and employment that ERI observes.

ERI forecasts that employment will be persistently lower by 42 person-years over the next decade if DOE transfers uranium at the rates specified in Scenario 1. While the assessed case involves significantly lower rates, DOE uses the Scenario 1 forecast in order to forecast employment effects conservatively. A decrease of 42 person-years is relatively small—approximately 4%—compared to overall employment. Notably, the industry has weathered significantly larger changes in employment in the past. Between 1998 and 2001, the industry went from employment at 1120 to 423. EIA, Domestic Uranium Production Report (2005). Similarly, from 2008–2009, the industry went from 1563 to 1096; a drop of 467 in a single year. EIA, 2013 Uranium Production Report, 10 (May 2014). Additionally, ERI points out that employment for 2014 likely declined by 114 person-years, even though DOE transfers did not change appreciably from 2013 to 2014. These comparisons indicate that the small change attributable to DOE's transfers will be well within the range of employment fluctuations that independent market conditions produce.

Some comments in response to the RFI, mentioned above, warn that employment losses may lead to a loss of intellectual capacity. The relevant employees have technical skills that can take time to acquire. If the lost employees have retired or moved into other fields, it may not be possible to restore them even as demand increases. While in principle replacements could be trained, these commenters argued that employment losses have been so severe that the industry is losing the capability to train replacements. Commenters provided no evidence to support these claims. Moreover, these commenters' suggestion is inconsistent with the industry experience of the past 20 years. The industry has more than once in the last 20 years experienced decreases in employment an order of magnitude above what ERI attributes to recent DOE transfers, and has maintained and, when appropriate, increased production. Thus, DOE does not expect its transfers in the assessed case will cause employment losses that threaten the intellectual reserves of the industry. DOE believes that the current levels of employment (and the expected future levels of employment) adequately protect against loss of this resource.

4. Changes in Capital Improvement Plans and Development of Future Facilities

As stated above, ERI reports that four new production centers began operation since 2009: One in 2010, one in late 2010/early 2011, one in 2013, and one in 2014. In addition, one new production center—Peninsula's Lance project—is expected to begin operations in 2015. 2015 ERI Report, 57. ERI explains that the new production centers may have been able to begin operations only because they were supported by fixed price term contracts that were signed when prices were substantially higher than they are currently—*i.e.* $55 to $70 per pound term price. At least one of these companies has directly stated that its project would not have been able to proceed at current price levels—$45 to $50 per pound term price. ERI also reports that some owners of proposed conventional mines outside the U.S. have stated that prices in the range of $60 to $70 per pound would be necessary for further development. 2015 ERI Report, 61.

Based on the above, ERI concludes, ''[i]t does not appear that removing the DOE inventory from the market and adding back the $2 to $3 per pound price effect attributed to the DOE inventory material . . . would necessarily increase current prices enough to change the situation regarding the viability of new production centers in the U.S.'' 2015 ERI Report, 62. However, ERI reports that some lower cost ISL projects in the U.S. may be able to move forward at current prices. 2015 ERI Report, 62.

NAC provides estimates of the site forward cost, including rate of return, for ten properties it considers to be under development.[75] [REDACTED]. NAC Report, 3–11. NAC does not directly apply its estimate of the price effect of DOE transfers to the production costs for these specific properties.

The UxC Report does not provide any specific estimates of production levels or costs at planned facilities. However, UxC has developed production cost data elsewhere in reports cited. UxC Uranium Suppliers Annual—December 2014 (2014); UxC Uranium Production Cost Study (2013). [REDACTED]. UxC Uranium Production Cost Study, 62, (2013). [REDACTED].

As with existing production centers, UxC [REDACTED].[76] [REDACTED]. *Id.* at 82–83.

EIA reports that production expenditures were $168.8 million in 2011, $187 million in 2012 and $168 million in 2013—when spread across annual production, these numbers represent approximately $41 per pound in 2011, $43 per pound in 2012, and $36 per pound in 2013. EIA, 2013 Domestic Uranium Production Report, 7, 11 (2014). Including costs related to drilling between 2011 and 2013 raises this figure by about $56 million per year per pound, and including land, exploration, and reclamation costs in those years increases these figures by a further $96 million per year. EIA, 2013 Domestic Uranium Production Report, 11 (2014). Some commenters argued that the average cost for a U.S. producer is $67.10 per pound—apparently the sum of the EIA figures for all costs, divided by the total of recent production. NIPC Comment of UPA, at 7. DOE is not convinced that this simple aggregation provides an accurate estimate of production costs. For one thing, some expenses, like reclamation, occur after production and therefore should be attributed to past production (sometimes long-past production) rather than current production. Some expenses, like exploration costs, relate to future production. U.S. production has varied over time, and will continue to do so. So accounting for past and future production costs as part of the cost of current production can lead to error. DOE believes a more reliable method for estimating the cost of

[75] NAC defines ''under development'' as a property for which ground breaking has begun. Note that NAC considers ten properties worldwide to be ''under development''; they are not limited to U.S. properties. NAC Report, 3–11.

[76] Information from this paragraph is collected from the two UxC studies mentioned above. The price bands come from UxC Uranium Production Cost Study, 80–84 (2013), and cost estimates in parentheses comes from UxC Uranium Suppliers Annual—December 2014 (2014) (except for data on [REDACTED], which come from UxC Uranium Production Cost Study, 111–12 (2013).

production, for purposes of forecasting the consequences of DOE uranium transfers, is to use industry reports such as UxC's, which provide data about the expected costs of actual projects.[77]

As with production at existing mines, DOE believes that production decisions are more likely to be based on future expectations about market prices and contracting trends than on a straightforward comparison of current market prices to production cost. The comments received were consistent with DOE's understanding. New production centers are a long-term investment, and new facilities require several years of lead-time before production can begin. Since market prices fluctuate over time, many producers are unwilling to bring a new facility into production without long-term supply contracts in place.

TradeTech's report included an estimate that DOE's transfers, at the 2,705 MTU per year rate, ''could be the deciding factor'' in whether a hypothetical miner continues production. TradeTech Report, at 22. The hypothetical mine has a marginal production cost of $47.41 per pound, a 50% exposure to the spot market price, and a long-term component to its realized price of $50. In addition, TradeTech assumes that the hypothetical mine requires a 10% margin to justify production. Observing that prices in the next couple years are forecast to range from $40 to $55 per pound, and that DOE transfers at 2,705 MTU per year would in TradeTech's estimate reduce prices by on average $2.43 per pound, TradeTech concludes that the $2.43 per pound difference ''could'' matter for the hypothetical mine.

Some commenters characterized the TradeTech report as ''overwhelming evidence'' that DOE's transfers are ''threatening the very existence of several U.S. producers.'' NIPC Comment of UPA, at 4. These commenters urged DOE to rely on TradeTech's hypothetical example for assessing the consequences of DOE transfers for future production. NIPC Comment of UPA, at 7. DOE does not consider this example appropriate for that purpose, and does not think it constitutes evidence that DOE's transfers actually threaten the viability of U.S. producers, for several reasons. The analysis appears to compare current production costs at the hypothetical mine to near-term spot prices. DOE believes a producer would actually make its long-term investment decisions on the basis of expectations about prices over the longer term and the availability of long-term contracts at an acceptable price. TradeTech's example does not reflect either of these factors. In addition, the hypothetical example uses assumptions that do not appear well justified. The hypothetical mine has average production costs of $47.41 per pound.[78] There also appear to be only one or two projects, out of the number being developed in the United States, that have expected production costs near the assumed figure. The hypothetical producer also has long-term contracts at an average price of $50 per pound, just 5.5% higher than the producer's assumed average cost. Yet, according to TradeTech's hypothetical, this producer needs a 10% margin to justify production. This hypothetical producer would have needed spot prices to be not just 10% higher than its costs, but even higher ($54.30 per pound) to compensate for the low price of its long-term contracts. It seems unlikely a producer would actually have developed such a speculative project. In short, the hypothetical example as a whole is inconsistent with DOE's understanding of how producers decide whether and when to invest in production resources.

Consistent with the analytical approach outlined above, DOE's task is to assess what the state of affairs would be with and without transfers in the assessed case. DOE agrees with ERI's conclusion that whether DOE makes these transfers is not likely to affect the economic viability of new U.S. production centers in development. The production cost estimates from NAC and UxC are consistent with ERI's conclusions. ERI reports that there may be some low-cost ISR production centers that can move forward at current market prices. This is consistent with estimates from NAC and UxC's of production costs at specific facilities that are currently under development. The only production center expected to begin operations in the near future is Peninsula's Lance. Both NAC and UxC estimate [REDACTED]. For such a project, DOE transfers may affect overall revenues but seem unlikely to change whether the project proceeds. [REDACTED]. Compared to current term market prices, one or two projects have production costs that are close to or just above the current market price, but in light of the low rate of term contracting activity in the next one or two years, these projects are unlikely to settle on contracts at the current term price.

DOE recognizes that, as some commenters explained, there has been limited investment in uranium projects in recent years. *E.g.,* RFI Comment of Uranerz, 4; RFI Comment of Energy Fuels, 4–5. However, although commenters attribute the decrease in investment to DOE's transfers of uranium, DOE believes that investment decisions reflect market conditions overall, primarily current market prices and expectations of future market price. The analysis described above identifies the amount of decrease that can reasonably be attributed to DOE's transfers. Ultimately, DOE must assess what the effect of future transfers will be. Prices have increased since the lows of the past two years, and future prices are now expected to be higher. As prices increase in the coming few years, term contracts will become available that would justify one or more additional projects with higher costs. A persistent $2–3 per pound price effect, as DOE forecasts for the assessed case, may delay investment on a given project for a time. But it does not appear that eliminating the effects of DOE transfers, would markedly change decisions whether to develop future production centers.

5. Long-Term Viability and Health of the Industry

As described above, ERI notes that U.S. industry production has risen since the start of DOE uranium inventory transfers for Portsmouth cleanup in December 2009. ERI also notes that four new operations began production since 2009, and one additional production center is expected to begin operations in 2015. 2015 ERI Report, 57.

ERI also presents its future expectations regarding demand for uranium. ERI's most recent Reference Nuclear Power Growth forecasts project global requirements to grow to approximately 182 million pounds annually between 2018 and 2020, approximately 15% higher than current requirements. Global requirements are expected to continue to rise to a level of 203 million pounds in 2025, approximately 28% higher than current

[77] UPA and others also stated that DOE should consider the fact that total drilling, exploration, and development expenditures decreased in 2013 compared to 2012 according to EIA. They also state that it is reasonable to expect that these expenditures were even lower in 2014. RFI Comment of UPA, at 3; RFI Comment of Uranerz, at 3. Since uranium prices decreased over this period, it is not surprising that producers reduced their activities to develop new resources. However, consistent with the analytical approach described above, the relevant question is what will be the effect on these activities of DOE transfers. DOE believes that a more reliable approach is to compare the expected market price with and without DOE transfers to estimated production costs at potential new production centers.

[78] That figure is well below what some commenters argued DOE should use—$67.10 per pound, based on the aggregate of EIA-reported costs and the amount of 2014 production.

requirements. 2015 ERI Report, 6–7. ERI presents a graph comparing global requirements, demand, and supply from 2013–2035. Global secondary supply and supply from current mines are expected to exceed global reactor demand until approximately 2018. However, if China's practice of purchasing amounts of uranium well in excess of its current reactor demand is included—what ERI terms ''Discretionary Strategic'' demand—global demand approximately equals supply from secondary supply and currently operating mines. 2015 ERI Report, 9–10. If planned expansions and new mines under development are included, supply is expected to exceed demand until approximately 2024, regardless of whether ''Discretionary Strategic'' demand is included.[79] In the time period following 2025, ERI forecasts that demand will significantly exceed supply. 2015 ERI Report, 9. In order to meet this demand, ERI anticipates that mines it terms ''planned'' and ''prospective'' will need to begin operations. 2015 ERI Report, 11.

A variety of other sources predict substantial increases in reactor requirements and/or demand.[80] TradeTech forecasts reactor-only growth at 3.52% per year through 2024. Total uranium requirements growth is much slower during this period due to stock building purchases which taper downward.[81] TradeTech Report, 34. The OECD and IAEA expect reactor requirements to grow by at least 35.4 million pounds[82] by 2025—representing approximately 21% of 2015 requirements.[83] OECD–IAEA, Uranium 2014: Resource, Production, and Demand, 105 (2014). In its Uranium Market Outlook for the 4th quarter of 2014, UxC similarly predicts significant increases in both requirements and demand in the long-term. UxC Uranium Market Outlook—Q4 2014, 56–60 (2014). Specifically, [REDACTED]. *Id.* at 60. [REDACTED]. *Id.* at 57.

Other sources also generally agree with ERI's forecast for supply. UxC's annual Uranium Market Outlook projects [REDACTED]. UxC Uranium Market Outlook—Q4 2014, 68 (2014). [REDACTED]. *Id.* at 69.

In addition to a predicted increase in demand, several sources predict a recovery in either spot or term uranium prices—or both. These forecasts are discussed above in Section IV.A.1, but they generally predict an increase in spot price to $50 by 2019 or 2020, and to $55.00 or $60.00 in the years thereafter.

Finally, DOE recognizes that the predictability of transfers from its excess uranium inventory over time is important to the long-term viability and health of the uranium industries. ERI has noted the importance of predictability ''for long-term planning and investment decisions by the domestic industry.'' 2015 ERI Report, 100; 2014 ERI Report, 60–61. Some commenters also stated that DOE transfers should be predictable. RFI Comment of UPA, at 2; RFI Comment of Cameco, at 2. Other comments stressed the importance of predictability to permit the industry to engage in long-term planning. NIPC Comment of Cameco, at 4; NIPC Comment of UPA, at 5. DOE notes that the upper scenario considered by ERI would represent continued transfers at rates consistent with the May 2014 determination and roughly similar to the May 2012 determination. Compare 2015 ERI Report, 25, with 2014 ERI Report, 28. Thus, DOE's section 3112(d) transfers have been stable for three years: DOE has transferred at essentially the rate identified in the May 2012 determination. The series of Secretarial Determinations has, DOE believes, made these transfers predictable. While the assessed case involves a lower rate of transfers, DOE does not believe a reduction of this magnitude will cause harmful uncertainty for the industry.

DOE recognizes that, as with any prediction, the future course of events may differ from forecasts. But section 3112(d) itself instructs DOE to predict the impact of its transfers, in that the statute requires a determination that a transfer ''will not'' have adverse material impacts on the domestic industries. Forecasts of reactor requirements should be fairly reliable, because constructing a nuclear reactor is a major investment requiring years to come to fruition and a reactor then operates for decades. A reactor that will need uranium in the next decade must either exist now or be at least in the planning stages now. Conversely, if a reactor is operating now, its operator has strong incentives to keep it running as long as possible, and the licensed lifetimes for reactors are known. Therefore, barring extreme events such as the Fukushima disaster and various large-scale policy responses to it, DOE believes it is possible to forecast reactor requirements with a fairly high degree of precision. The various sources DOE has consulted, including the ERI report, offer similar forecasts, and DOE concludes it is appropriate to rely on those forecasts.

Forecasts of production may be somewhat more uncertain, for several reasons. Developing a new mining project does not take as long as building a new reactor, and the process differs also in terms of when money is spent over the course of the development. If a new reactor would be running in 2020, a significant amount of investment will already have been made by this point. So it is likely that, while schedules might slip, the reactor would indeed begin operating. Mines that might be operating in 2020 include projects that are still in a more speculative phase of development. A producer might halt development for various reasons, including market conditions or a discovery that the uranium resource was smaller than expected. These factors could make the eventual supply smaller than forecasted.

Nonetheless, the rough course of future supply can be predicted with a reasonable degree of reliability. Producers know the amount of uranium available at their existing resources. Technology might improve to permit more uranium to be recovered at a given price—a phenomenon that has reshaped the oil industry. But DOE is not aware of any technology in development that would significantly alter mine economics in the next few years. Consequently, DOE believes it can rely on forecasts about the depletion of

[79] ERI assumes that China's discretionary strategic inventory building will taper off by 2023. 2015 ERI Report, 10. This is generally consistent with other projections regarding Chinese strategic inventory purchasing behavior. *See* TradeTech Report, 41–42; NAC Report, at 3–4.

[80] DOE notes that uranium ''demand'' and reactor ''requirements'' are different. Requirements refers to an estimate of the amount of uranium needed to support operating reactors in a particular year. Demand includes additional purchased quantities for strategic or discretionary purposes. For example, in recent years China has purchased quantities of uranium far in excess of its reactor requirements. 2015 ERI Report, 10–11; TradeTech Report, 41–42; NAC Report, 3–2 to 3–5.

[81] TradeTech also appears to assume China's stock building purchases will cease to outpace Chinese requirements around 2023. TradeTech Report, 41–42. TradeTech also notes that most Japanese reactors are expected to resume operation by 2020 while around 70% of contracted deliveries continue to be made. *Id.* at 35. TradeTech projects that this will lead to decreased demand from Japan after 2020 as Japanese reactors utilize excess stocks that were delivered while the reactors were not operating. *Id.* at 36. Despite decreased demand during this period from Japan, China, and other countries, TradeTech still predicts that uranium demand will grow by approximately one percent per year between 2015 and 2030. *Id.* at 33.

[82] Converted from metric tons uranium in U_3O_8 (MTU) using a conversion rate of 2,599.79 pounds U_3O_8 per MTU.

[83] This represents OECD–IAEA's low growth scenario. The high growth scenario anticipates growth of almost 90 million pounds, approximately 50% above the high-growth scenario for 2015. *Id.*

existing production centers. Forecasts about the amount of uranium available at a mine still in the planning phase are necessarily more uncertain. Any given mine might prove to have more or less capacity than currently forecasted. In aggregate, these differences should average out to some degree, so that overall forecasts of aggregate supply are appropriate predictions of the likeliest course of events. The various sources DOE has consulted offer similar forecasts on this point, and DOE concludes it is appropriate to rely on them.

Even if existing production centers continued producing uranium at their current rates, prices could be expected to increase because requirements will increase. Consistent with the ordinary operation of supply and demand, higher prices would be necessary to bring additional supplies into the market. In fact, as existing production centers are depleted, the predicted replacements will have slightly higher production costs. Thus, higher prices will be necessary in the future even to maintain production at current levels. For these reasons the price of uranium is likely to increase over the coming decade.

Most sources DOE has reviewed agree that there will be an increase, although the specific estimates of that increase vary. This price increase is expected to take place even with DOE transfers. *See* Figures 5 & 6, UxC Report, 11.

The effect of DOE transfers on this process is not certain. UxC projects that DOE transfers will essentially slow the rate of this price increase. For example, [REDACTED]. *Id.* Even if this projection is correct, DOE transfers would only have the effect of slightly delaying the development of future production facilities. Significantly, DOE transfers will not prevent new facilities from coming online, and is not expected to permanently affect the viability of any new production centers. At worst, the effect of DOE transfers in the long run is equivalent to the difference in present value based on earnings beginning later in time. DOE does not believe that this difference is significant enough to appreciably affect the long-term viability and health of the industry.

6. Russian HEU Agreement and Suspension Agreement

Section 3112(d) of the USEC Privatization Act requires DOE to ''take into account'' the sales of uranium under the Russian HEU Agreement and the Suspension Agreement. Consistent with this instruction, DOE believes this assessment should consider any sales under these two agreements that are ongoing at the time of DOE's transfers.

Under the Russian HEU Agreement, upon delivery of LEU derived from Russian HEU, the U.S. Executive Agent, USEC Inc., was to deliver to the Russian Executive Agent, Technabexport (Tenex), an amount of natural uranium hexafluoride equivalent to the natural uranium component of the LEU. The USEC Privatization Act limited the volume of that natural uranium hexafluoride that could be delivered to end users in the United States to no more than 20 million pounds U_3O_8 in each year after 2009. ERI has in the past analyzed material from the Russian HEU Agreement as part of worldwide secondary supply. DOE notes that the Russian HEU Agreement concluded in December 2013. Thus, there are no ongoing transfers under this agreement.[84]

The current iteration of the Suspension Agreement, described above in Section I.D.3.b, sets an annual export limit on natural uranium from Russia. 73 FR 7705 (Feb. 11, 2008). That agreement provides for the resumption of sales of natural uranium and SWU beginning in 2011. While the HEU Agreement remained active (*i.e.* 2011–2013), the annual export limits were relatively small—equivalent to between 0.4 and 1.1 million pounds U_3O_8. After the end of the Russian HEU Agreement, restrictions range between an amount equivalent to 11.9 and 13.4 million pounds U_3O_8 per year between 2014 and 2020. 73 FR 7705, at 7706 (Feb. 11, 2008). Material imported from Russia in accordance with the Suspension Agreement is not derived from down-blended HEU; thus, this material is part of worldwide primary supply as analyzed by ERI in the 2015 ERI Report. This material is also presumably accounted for in the various projections and models developed by TradeTech, UxC, and NAC International. Thus, DOE's analysis takes sales of uranium under the Suspension Agreement into account as part of overall supply available in the market.

7. Mining Industry Conclusion

After considering the factors discussed above, DOE concludes that transfers under the assessed case will not have an adverse material impact on the domestic uranium mining industry. As explained above, DOE transfers under the assessed case will continue to exert some downward pressure on the market price for uranium concentrates. DOE forecasts that about $2.70 of price suppression will be reasonably attributable to DOE transfers; this is somewhat smaller than the effect attributable to transfers in the past few years.

Because the vast majority of deliveries of uranium concentrates take place under long-term contracts that allow producers to realize prices based on term prices prevailing at the time the contracts were entered, DOE concludes that the average effect on the realized price of U.S. producers under current contracts is closer to $1.75. For future term contracts, price suppression associated with DOE transfers would decrease the base price for these contracts, potentially decreasing the average realized price over the life of each contract. However, DOE concludes that this type of effect will be minimal because term contracting activity is expected to remain low during the next few years.

DOE transfers are expected to have a small effect on employment in the domestic industry, but the magnitude of this effect is well within the range of employment fluctuations the industry has experienced in the past due to market conditions unrelated to DOE transfers.

Even focusing on the entities most likely to be impacted—*i.e.* producers that sell primarily on the spot market and are thus not protected from fluctuations in the spot price—it is not likely that removing the $2.70 price effect attributable to DOE transfers under the assessed case would be enough to materially change the relationship between price and cost for any producer with respect to production levels at currently operating facilities or decisions whether to proceed with developing new production centers. Both types of decisions involve considerations beyond current spot prices, and they likely will be based on expectations about future trends in market price. DOE concludes that, given the expected increases in future demand for uranium concentrates and, more importantly, the expected increases in market prices, the price effect attributable to DOE might delay decisions to expand or increase production capacity but would not change the eventual outcomes. DOE does not believe that these effects have the substantial importance that would make them ''adverse material impacts'' within the meaning of section 3112(d).

[84] Following the end of the Russian HEU Agreement, Tenex signed a commercial agreement to provide EUP to customers in the United States. Commenters appear to suggest that this material is equivalent to a continuation of the Russian HEU Agreement. NIPC Comment of ConverDyn, Enclosure, at 4. DOE notes that this material is not produced from down-blended HEU; it is from commercial primary supply. Thus, it is covered under the Suspension Agreement and included within ERI's estimates of worldwide supply, as described in text.

B. Uranium Conversion Industry

The domestic uranium conversion industry consists of a single facility, the Metropolis Works (MTW) in Metropolis, Illinois. This facility is owned and operated by Honeywell International Inc. MTW has a nameplate capacity of 15,000 MTU as UF_6. ConverDyn, Inc., (''ConverDyn'') is the exclusive marketing agent for MTW and submitted comments in response to DOE's notices. In what follows, DOE will refer to MTW or ConverDyn, interchangeably, because the two appear to have essentially the same interests in uranium markets.

1. Prices for Conversion Services

Like market prices for uranium concentrates, conversion market prices are generally described in terms of the spot price and the term price. This section discusses the potential impacts of DOE transfers on these two prices. For reference, as of March 30, 2015, UxC's spot price indicator was $7.50 per kgU as UF_6 and its term price indicator was $16.00 per kgU as UF_6.

Three of the market analyses discussed above—those by ERI, TradeTech, and UxC—contain estimates of the effect of DOE transfers on the market prices for conversion services: ERI, TradeTech, and UxC. This section begins with a summary of each report and then discusses DOE's review of the reports' methodologies and conclusions. This section concludes with a discussion of how a change in conversion market prices would affect the domestic uranium conversion industry. A principal mechanism through which such a change in market price could impact individual producers is through the effect on the realized price of primary converters.

a. Energy Resources International Report

DOE tasked ERI with estimating the effect of DOE transfers on the market prices for conversion services. To estimate this effect, ERI employed a market clearing price model very similar to what is described above for the uranium market. As with uranium concentrates, ERI constructed individual supply and demand curves for conversion services and estimated the clearing price with and without DOE transfers. 2015 ERI Report, 44.

DOE tasked ERI with estimating the effects of DOE transfers under the same three scenarios described in Section IV.A.1. The levels of the different scenarios are outlined above in Table 4 in terms of natural uranium equivalent.[85] All the transfers in the assessed case have the potential to displace conversion services. The natural uranium hexafluoride that DOE transfers could displace conversion services directly, in that this material is the ordinary output of a conversion facility. The low-enriched uranium that DOE transfers could also displace conversion services because natural uranium must be converted into uranium hexafluoride before it can be enriched. A purchaser of low-enriched uranium from DOE transfers would purchase correspondingly less conversion services.[86] As conversion services are denominated in kgU as UF_6, the figures reported in Table 4 also refer to the amount of conversion services embodied in the DOE inventory. As with uranium concentrates, the assessed case falls between Scenarios 1 and 2.

Using its market clearing approach, ERI estimates that DOE transfers will have the effects listed in Table 11. As with uranium concentrates, the relationship between the amount of transfers under each scenario and the price effect is essentially linear for each year ERI analyzed (2015–2024). Compare Table 3.7 to Table 4.2 of 2015 ERI Report, 25–26, 45. Therefore, the price effect of DOE transfers in the assessed case can be interpolated from ERI's estimates.

TABLE 11—ERI'S ESTIMATE OF EFFECT OF DOE TRANSFERS ON CONVERSION PRICES IN $ PER kgU AS UF_6

[Market clearing approach]

2015 ERI Report				
	ERI Scenario 1	ERI Scenario 2	ERI Scenario 3	Assessed case (interpolated)
2015	$0.90	$0.70	$0.10	$0.90
2016	0.90	0.60	0.00	0.70
2017	0.80	0.60	0.00	0.70
2018	1.00	0.80	0.20	0.90
2019	0.80	0.90	0.40	1.00
2020	0.90	1.30	0.70	1.00
2021	1.00	1.00	0.80	1.00
2022	0.90	0.80	0.70	0.80
2023	1.00	0.90	0.80	0.90
2024	0.80	0.80	0.60	0.80
Average (2015–2024)	0.90	0.80	0.40	0.90

As with uranium concentrates, it is important to emphasize that this is not a prediction that prices will drop by the specified amount once DOE begins transfers following a new determination. A level of price suppression consistent with the estimate for Scenario 1 would, on ERI's analysis, already be reflected to some degree in the current market price because DOE is currently transferring uranium at that rate. 2015 ERI Report, 44. The price suppression that ERI estimates would persist under Scenario 3 is largely ERI's estimate of the consequence of past DOE transfers, from which some of the uranium is still expected to be entering the market in future years.

[85] As noted above, the transfer rates for these scenarios refer only to the level of uranium transfers for cleanup at Portsmouth and down-blending of LEU. The level of transfers for other DOE programs is the same in all three scenarios.

[86] The LEU that DOE transfers is in the form of uranyl nitrate, which must be converted to uranium oxide in the fuel fabrication process. Analogously, enriched uranium hexafluoride must also be transformed into uranium oxide. If there were a difference in cost between these two chemical processes, buyers might be willing to pay more (or less) for the enriched nitrate than for enriched hexafluoride, and the market effect of LEU transfers would be somewhat more complicated to predict. However, DOE is not aware of any substantial difference in these costs.

b. TradeTech Report

In addition to its estimate of the price effect of DOE transfers on the uranium concentrate market, TradeTech estimates the effect on the price of conversion services. A summary of TradeTech's estimates appears in Table 12. It appears that TradeTech developed this estimate using its econometric Dynamic Pricing Model. TradeTech Report, 14. Using its model, TradeTech estimates that DOE's transfer reduced the spot price by an average of $2.13 per kgU as UF_6 between January 2012 and December 2014. TradeTech Report, 17. TradeTech also forecasts that continued DOE transfers at current rates would reduce the spot price by an average of $0.91 per kgU as UF_6 between January 2015 and December 2016. TradeTech Report, 21.

TradeTech also provides predictions for the effect of DOE transfers at several decreased transfer rates. If DOE transfers decreased to 75% of current levels, TradeTech estimates that the spot price would increase by an average of $0.21 per kgU as UF_6 between January and 2015 and December 2016. TradeTech, 31.[87] Based on TradeTech's estimate of the price suppression caused by DOE transfers at current levels, it appears that TradeTech is forecasting that price suppression given transfers at 75% of current levels would be $0.70. If DOE transfers decreased to 50% of current levels, TradeTech predicts that the spot price would increase by an average of $0.43 per kgU as UF_6 between January and 2015 and December 2016. TradeTech, 30. This corresponds to a price suppression of $0.48. If DOE transfers decreased to 25% of current levels, TradeTech forecasts that the spot price would increase by an average of $0.66 per kgU as UF_6 between January and 2015 and December 2016. TradeTech, 29. This corresponds to a price suppression of $0.25. As with uranium concentrates, the TradeTech Report does not state the numerical volumes that correspond to these decreased transfer rates. However, DOE notes that the 2,100 MTU rate is slightly above 75% of the level included in the May 2014 Determination. Thus, DOE believes that TradeTech's ''75%'' figure is roughly equivalent, although slightly below, that level.

TABLE 12—TRADETECH'S ESTIMATE OF EFFECT OF DOE TRANSFERS ON CONVERSION SPOT PRICE IN $ PER kgU AS UF_6

TradeTech Report	
Transfer rate (compared to current)	Estimated price effect (2015–2016)
100%	$0.91
75%	0.70
50%	0.48
25%	0.25

c. UxC Report

UxC's U–PRICE and SWU–PRICE econometric models predict the markets' reaction to changes in supply for the uranium concentrate and enrichment industries. UxC does not directly model the conversion services market. Instead, UxC relies on other evidence to conclude that the price effect of DOE transfers on spot conversion prices have been ''at least equal to, if not greater than, the impact on spot uranium prices.'' Specifically, UxC notes that much of the world's spot conversion is sold in conjunction with uranium through contracts for UF_6. UxC also notes that over the past few years the UF_6 price has fallen as much as the U_3O_8 price has on a percentage basis. Finally, UxC notes that the Ux North American UF_6 Price has been below the Ux NA UF_6 value (*i.e.* the sum of spot uranium and spot conversion prices for a given quantity of UF_6) over most of the period of DOE transfers. UxC Report, 15. With respect to the future effect of DOE transfers, UxC expects that DOE transfers will continue to have a similar effect on spot conversion prices and a somewhat less but still ''noticeable'' effect on term conversion prices. UxC Report, 16.

d. Effect of DOE Transfers on Market Price

DOE has reviewed each of the market analyses described above. Each report uses a somewhat different methodology in estimating the effects of DOE's uranium sales. ERI's approach is likely to greatly overestimate the effect of DOE's transfers on term conversion prices because it rests on the assumption that conversion prices arise from a competitive market price-setting mechanism. While the analysis would be reasonable if the term price for conversion had a competitive price-setting mechanism, DOE believes that it does not. The market includes only five significant suppliers, one of which provides services almost exclusively to Chinese purchasers. This market structure could, on its own, make the market susceptible to parallel pricing in which rational pricing decisions by individual firms could lead the market price to be unresponsive to supply and demand changes.[88] Conversion services are also homogeneous from the market's point of view; converters take in uranium concentrates meeting industry standards and produce uranium hexafluoride meeting industry standards. The main buyers of conversion services, nuclear utilities, are relatively insensitive to the price of conversion. As noted above, medium-term demand is generally inelastic because a utility must supply fuel for its reactors and the price of fuel is a relatively small part of its generation cost. Conversion is an even smaller fraction of that cost, because (using current term prices) conversion accounts for only seven to nine percent of the total cost of enriched uranium product. Meanwhile, conversion is a necessary step in the fuel cycle, and conversion facilities operate with a relatively high degree of investment compared to their variable costs. To ensure that conversion capacity remains available, it could be rational for utilities to accept and commit to higher prices than a free price mechanism reflecting available supply and demand would produce. In short, the insensitivity of buyers to conversion prices in the medium term, combined with the market structure, would make it likely that market-based pricing mechanisms would not function freely in the medium-term conversion market.

Consistent with this expectation, the term price for conversion has not reacted to fairly large market shocks, much less changes in the rate of DOE's transfers. In 2010, when term prices were around $11–13 per kgU, ConverDyn announced that it would no longer enter long-term contracts for less than $15 per kgU. 2014 ERI Report, 12; Michael Schwartz & Julian Steyn, ''Supply Margins Erode,'' *Nuclear Engineering International* (Oct. 6, 2011), available at *http://www.neimagazine.com/features/featuresupply-margins-erode/*. This behavior would be surprising if the medium-term conversion market were a competitive market in which the lowest

[87] Figures 21–24 of the TradeTech Report show TradeTech's estimates for the price impact at a range of different transfer rates. Although these charts and the related text refer to ''Transfers at [25, 50, or 75] Percent of Established 2014 Volumes,'' it appears that these charts actually reflect an estimate for a 25%, 50%, or 75% *decrease* relative to current levels, rather than transfers at the specified percentage of current levels.

[88] *See generally* DOJ/FTC Horizontal Merger Guidelines, chapter 7. Depending on the calculation basis, the Herfindahl–Hirschman Index of the conversion services market is between 1200 and 2800. The former is near the threshold of what, under the Guidelines, would be considered an unconcentrated market in which, absent additional circumstances, uncompetitive behavior would not likely be a concern. The latter figure would qualify the market as highly concentrated.

price attracts the most business. By contrast, it is consistent with the notion that this market is prone to parallel pricing decisions. Furthermore, the term market price increased shortly after ConverDyn's announcement to $15 per kgU, and then to $16.50 per kgU after ConverDyn made another announcement that it would not enter into long-term contracts for less than $16.50 per kgU. *See* Kevin P. Smith, *ConverDyn* v. *Moniz,* Case no. 1:14–cv–01012–RBW, Document 17–7, at ¶ 16 (July 7, 2014). It remained at $16.50 per kgU even as the Fukushima disaster led to a 25% decrease in demand for conversion, and while the uranium term price decreased by 50% and the conversion spot price decreased by 50%. The price also did not respond when DOE announced in May 2012 that it would increase transfers for Portsmouth cleanup to 2,400 MTU per year, or when the much larger-scale sales of Russian-origin uranium ceased in 2013.

In sum, the conversion term price has not responded in recent years to major market disruptions. It appears that conversion providers are able to command roughly $16 per kgU regardless of the level of demand or of secondary supply. While it remains conceivable that some very small price effect could be attributed to DOE's transfers, DOE concludes that ERI's forecast of $0.90 per kgU is a very substantial overestimate.

By contrast, the spot market in conversion would be more likely to have a competitive price-setting mechanism. In the spot market, conversion providers are in full competition with sources of secondary supply, many of which might not participate on the medium-term market. For example, enrichers that engage in underfeeding depending on spot prices of uranium and enrichment are unlikely to enter into long-term contracts to supply the resulting excess uranium. Meanwhile, demand on the spot market includes some buyers, like brokers, that purchase relatively little on the long-term market and may be more sensitive to price. Indeed, conversion spot prices do fluctuate by amounts comparable to the fluctuations in uranium concentrates spot prices. And conversion spot prices appear to respond to disruptions in supply or demand. For example, spot prices decreased by 50% in the months following the Fukushima disaster, and they also increased by 50% after MTW announced an extended shutdown in 2012. For these reasons, DOE concludes that market-based economic modeling like what ERI and TradeTech performed for uranium spot prices is also an appropriate method to forecast conversion spot prices in the near term.

TradeTech provides an econometric model that is based roughly on uncommitted supply and demand. For that reason, and reasons like those discussed above with respect to the analogous models for uranium prices, DOE relies on TradeTech's forecast for near-term conversion spot prices.[89] It bears emphasis that as with uranium prices, forecasts of conversion spot prices in the medium term are highly uncertain because uncommitted supply and demand are only a small portion of the overall market.[90]

As mentioned above, the assessed case is similar to the 75% scenario that TradeTech analyzed. TradeTech forecasts that in the near term, DOE transfers at that rate would produce a persistent price suppression of about $0.70 per kgU, on average, or about 8.7% of current spot prices. In addition, ERI employs its market clearing model to predict a very similar price effect, approximately $0.90 in 2015 and $0.70 in 2016 and 2017.[91] For these reasons, DOE concludes that $0.70–$0.80 is a reasonable, although somewhat conservative, estimate of the effect of DOE transfers in the spot market over the next several years and notes that, given that the market price currently reflects DOE transfers at a rate of 2,705 MTU, conversion spot prices will be subject to a smaller price suppression than at present. DOE concludes that its transfers have had essentially no effect on the term price for conversion and will continue not to affect the term price.

e. Effect on Realized Price

As with uranium concentrates, market prices would affect MTW chiefly through their effect on the price it actually realizes for its services. Since the domestic conversion industry consists of only one producer, the effect of DOE transfers depends on the mix of contracts on which MTW's services are sold: The proportion of spot and term contracts, and the extent to which these contracts lock in prices higher (or lower) than current market prices or conversely expose MTW to spot prices.

No commenter provides specific information about the current realized prices achieved in the conversion industry, and no commenter directly estimates the effect of DOE's transfers on realized prices. ConverDyn is not a publicly traded company, and neither it nor Honeywell routinely make public information about contracting strategies and realized prices for MTW.[92] However, DOE believes that the following information is relevant to ConverDyn's contracting practices and its realized price.

ConverDyn has stated in the past that the conversion market generally relies on long-term contracts. Declaration of Malcolm Critchley, *ConverDyn* v. *Moniz,* Case no. 1:14–cv–01012–RBW, Document 7–3, at ¶ 37 (June 23, 2014). ConverDyn has also stated that these long-term contracts are generally ''linked, at least in part, to market prices at the time of the contract.'' *Id.* ConverDyn's March 10, 2014 letter to DOE [REDACTED]. *See* Letter from Malcolm Critchley, ConverDyn, to Peter B. Lyons, DOE, 6 (Mar. 10, 2014). In that same letter, ConverDyn explained [REDACTED]. *Id.* at 7. ConverDyn then states, [REDACTED]. *Id.*

Traxys, a brokerage and trading firm active in the uranium markets, has stated that ConverDyn specifically sells conversion services ''almost exclusively'' on long-term contracts. Declaration of Kevin P. Smith, *ConverDyn* v. *Moniz,* Case no. 1:14–cv–01012–RBW, Document 17–7, at ¶ 16 (July 7, 2014). Because Traxys is a frequent participant in the markets in

[89] ConverDyn states that DOE should recognize the limits of an economic model in a market with low liquidity. TradeTech's forecast explicitly takes the liquidity of these markets into account in modeling active supply and active demand. TradeTech Report, at 2–4.

[90] DOE does not place much weight on UxC's rough estimate of conversion spot prices based on a premise that the effect of DOE transfers on spot prices should be about the same, proportionally, as the effect on uranium prices. UxC's U–PRICE and SWU–PRICE models appear not to be designed to forecast conversion prices, and UxC's premise is not well justified. The conversion and uranium markets are distinct in many ways. Uncommitted conversion supply is different from uncommitted uranium supply, among other reasons because conversion providers have much higher ratios of fixed to variable costs than do uranium producers.

[91] ConverDyn argues that DOE and ERI have confused sales on the ''term market'' with ''buy and hold'' or ''carry trade'' sales. NIPC Comment of ConverDyn, Enclosure, at 5. DOE notes that ERI's market clearing model does not depend on whether DOE sales are made under spot contracts, term contracts, or some other type of contract.

[92] ERI notes that ConverDyn's realized price has increased over the last decade. Even in the absence of publicly available data about ConverDyn's pricing, this conclusion seems nearly inevitable because term prices have increased from $10 to $16 per kgU. ERI also suggests that ConverDyn may have an average realized price, at present, of around $14 per kgU. While ConverDyn's average realized price is probably lower than current term prices because some proportion of its long-term contracts date from a time of lower prices, ERI's particular figure seems to be based mainly on ConverDyn's claim to be operating at a loss. It is thus not a very precise estimate. In any case, DOE's analytical task is to understand how ConverDyn's realized price would be different with and without transfers under the assessed case. As the discussion below indicates, DOE can perform that task without necessarily having a precise figure for ConverDyn's current average realized price.

which ConverDyn sells, and because this statement appeared in a declaration filed in court, DOE considers Traxys's observation reliable. Traxys has also stated that ConverDyn exercises significant pricing power in the market. Traxys refers to a 2011 letter from ConverDyn to its customers notifying them that it would not sell conversion services for less than $16.50 per kgU. *Id.* Since then, the term price indicator for conversion services has remained remarkably stable, even as spot prices for conversion have fluctuated. 2015 ERI Report, 12. UxC's annual conversion outlook [REDACTED]. UxC Conversion Market Outlook—December 2014 (2014). [REDACTED]. *Id.* at 32. [REDACTED]. *Id.* at 36.[93] UxC also estimates that primary production totaled approximately [REDACTED], about [REDACTED] of which was from MTW. *Id.* at 45. Assuming the spot contracting activity from primary producers was divided proportionately by production among the Western converters,[94] ConverDyn's share would be [REDACTED]. *Id.* Conducting the same calculation using [REDACTED]. *Id.*

To the extent that ConverDyn engages in spot sales, they represent no more than 5% of its total sales, and likely represent significantly less. Considering this in combination with ConverDyn's statements about its contracting practices, namely that ConverDyn's long-term contracts are priced at the prevailing term price (with some escalation for inflation), DOE concludes that ConverDyn has virtually no exposure to the spot price.

This conclusion is somewhat counterintuitive. ConverDyn evidently has a high proportion of fixed costs. If variable costs are low, then the marginal cost of an additional unit of production should be very low, likely below the current spot price. In addition, ConverDyn states that it has excess capacity at its facility. NIPC Comment of ConverDyn, Enclosure, at 7. One would expect a facility with low marginal cost and excess capacity to sell any additional capacity on the spot market. However, the conversion market is characterized by a very small number of primary producers, and ConverDyn has demonstrated that it has significant influence over the price. Furthermore, the vast majority of contracting activity in conversion services continues to take place on the term market. DOE believes that this can be explained by utilities' preference for security of long-term supply. As ConverDyn explains, the term price for conversion is set based on the price necessary to include all costs of operations, capital recovery, and a return on investment. NIPC Comment of ConverDyn, Enclosure, at 5. Although utilities obviously have an interest in keeping variable costs for fuel as low as possible, paying prices that are not sufficient to cover a conversion providers' costs may, over time, jeopardize the continued operation of primary conversion facilities. By paying the premium associated with the term price, utilities can help prevent this outcome by paying a price that allows these facilities to cover their full operation and capital costs. UxC's reports regarding industry concerns support this concept, reflecting [REDACTED]. UxC Conversion Market Outlook—December 2014, 73 (2014).

Based on the above, it is unsurprising that ConverDyn is unwilling to enter into contracts at the spot price. A rational producer of conversion services with high fixed cost may be willing to reduce production rather than sell conversion services at a price that is not sufficient to cover the set of forward costs described below, even if the market price is higher than its marginal cost per unit. UxC's estimates of current production provide evidence that some primary converters have in fact adopted this strategy. Specifically, [REDACTED]. UxC Conversion Market Outlook—December 2014, 46 (2014).

Given that ConverDyn sells conversion services almost exclusively through term contracts, it follows that the effect on ConverDyn's realized price depends on the effect of DOE transfers on the term price. However, as noted above, DOE concludes that its transfers have had, and will likely continue to have, essentially no effect on term prices for conversion. Consequently, DOE transfers under the assessed case will have very little effect, if any, on the pricing of ConverDyn's term contracts.

DOE recognizes that this conclusion is contrary to an assertion that ConverDyn has made. ConverDyn has claimed that price suppression due to DOE transfers has caused it to lose millions of dollars in revenue. ConverDyn's analysis apparently applied the supposed price suppression across all the company's sales. DOE does not find ConverDyn's analysis convincing. ConverDyn stated in its March 10, 2014 letter that price suppression [REDACTED]. Letter from Malcolm Critchley, ConverDyn, to Peter B. Lyons, DOE, 7 (Mar. 10, 2014). ConverDyn, citing to the 2012 ERI report, states that it developed these estimates by applying a 5.8% price impact to contracts awarded since the start of the DOE sales program in 2009, and to expected futures sales between 2014 and 2016. *Id.;* Supplemental Declaration of Malcolm Critchley, *ConverDyn* v. *Moniz,* Case no. 1:14–cv–01012–RBW, Document 21–2, at ¶ 8 (July 14, 2014). But in 2009, DOE transferred uranium at a rate closer to 1,200 MTU per year, and it did not begin transferring at 2,800 MTU per year until 2012. Even if DOE transfers beginning in May 2012 suppressed term prices by 5.8%—which DOE has concluded they did not—ConverDyn offers no explanation for why transfers at the prior, lower rate should also have had a 5.8% price impact. More importantly, as discussed in the previous section, the term conversion price appears to respond very weakly, if at all, to changes in supply and demand for conversion services. Given the stability of the term conversion price since 2010, in the face of major market shocks and also despite the May 2012 increase in DOE's transfers, DOE does not believe transfers under the assessed case will appreciably affect the price at which ConverDyn makes long-term contracts.

2. Production at Existing Facilities

As stated above, there is only one conversion facility in the United States, the Metropolis Works facility (MTW) operated by Honeywell International. ConverDyn is the exclusive marketing agent for conversion services from this facility. This section focuses on two types of potential effects of DOE transfers on production levels at MTW: Loss of sales volume for conversion services from MTW, and change in average production costs at MTW.

a. Sales Volume

The nominal capacity of the Metropolis Works facility is 15 million kgU as UF_6. However, the facility generally operates below that level and has consistently produced no more than 11–12 million kgU in recent years. Supplemental Declaration of Malcolm Critchley, *ConverDyn* v. *Moniz,* Case no. 1:14–cv–01012–RBW, Document 21–2, at ¶ 10 (July 14, 2014).

ERI estimated the effect of DOE transfers on production at MTW on a series of assumptions based in part, on

[93] [REDACTED]. UxC Conversion Market Outlook—December 2014, 34–36 (2014).

[94] The converters are typically divided into two groups, the ''Western'' converters and the ''non-Western'' converters in Russia and China. The Western converters consist of MTW, Cameco's Port Hope facility in Ontario, Canada, AREVA's Comurhex facility in France, and the former Springfield-Westinghouse plant in the UK (closed in 2014). There is also a very small conversion facility in Sao Paulo, Brazil, with a capacity of approximately 100,000 kgU as UF_6. For comparison, the nameplate capacity of MTW is 15 million kgU as UF_6.

various statements from ConverDyn.[95] ERI estimates that production at this facility was approximately 11 million kgU as UF_6 per year prior to the loss of sales associated with Fukushima. Because ConverDyn has stated that this volume loss was approximately 25%, ERI estimates current sales volume at 8.25 million kgU as UF_6. 2015 ERI Report, 65. Based on statements from Traxys, the entity that currently purchases the material that DOE transfers to Fluor B&W Portsmouth for cleanup work at the Portsmouth Gaseous Diffusion Plant, ERI assumes that 50% of the material used for cleanup at Portsmouth and 100% of all other DOE material enters the U.S. market. 2015 ERI Report, 65–66. To estimate ConverDyn's U.S. and worldwide market share, ERI refers to a statement from ConverDyn that its share of the U.S. market for conversion services is 25%. ERI uses this to calculate ConverDyn's share of the international market as 16% by subtracting an amount equivalent to 25% of the U.S. market from ERI's estimate of ConverDyn's total sales volume. 2015 ERI Report, 68.

A summary of ERI's estimates of the effect of DOE transfers on ConverDyn's sales volume appears in Table 13. Using the assumptions described above, ERI estimates that under Scenario 1, DOE transfers decrease ConverDyn's market volume by 0.7 million kgU, or 8%. Under Scenario 2, ERI estimates that DOE transfers decrease ConverDyn's market volume by 0.5 million kgU, or 6%. Under Scenario 3, ERI estimates that DOE transfers decrease ConverDyn's market volume by 0.1 million kgU, or 1%. 2015 ERI Report, 69–70. As with ERI's price estimates discussed above, these estimates do not suggest that were DOE to transfer uranium in accordance with Scenario 1, ConverDyn would lose the predicted volume of sales. DOE has been transferring at or above the rate of Scenario 1 for nearly three years. On ERI's analysis, to some degree the estimated effect has already occurred. Transfers in accordance with Scenario 1 would continue the effect, and transfers in accordance with Scenario 2 or 3 would lead to an increase in ConverDyn's sales volume in the long term by the amount ERI predicts.

TABLE 13—ERI'S ESTIMATE OF DECREASE IN CONVERDYN'S SALES VOLUME[96]

	Volume (million kgU)	Percent change
Scenario 1	0.7	8
Scenario 2	0.5	6
Scenario 3	0.1	1

ConverDyn's comments in response to the RFI and NIPC do not provide a separate estimate of the effect of DOE transfers on its sales volume.[97] ConverDyn's comments refer to the relevant sections of the 2014 ERI Report and 2015 ERI Report regarding its sales volume and production costs. RFI Comment of ConverDyn, Enclosure, at 5; NIPC Comment of ConverDyn, Enclosure, at 9. With respect to the ERI Reports, ConverDyn does not refute or confirm the assumptions ERI used in its analysis regarding ConverDyn's sales volume, market share, or production costs.[98] ConverDyn also incorporated by reference into its comments a document it submitted to DOE in March 2014. RFI Comment of ConverDyn, Enclosure, at 5 n.12; NIPC Comment of ConverDyn, Enclosure, at 1 n.1. That document provides estimates of the effect of DOE transfers on ConverDyn's sales volume and profits, but it does not provide financial information demonstrating that those effects have occurred or supporting analysis explaining why a given change in ConverDyn's sales or revenue should be attributed to DOE transfers. Letter from Malcolm Critchley, ConverDyn, to Peter B. Lyons, DOE (Mar. 10, 2014); *see also* Supplemental Declaration of Malcolm Critchley, *ConverDyn* v. *Moniz,* Case no. 1:14–cv–01012–RBW, Document 21–2, at ¶ 7 (July 14, 2014). Specifically, ConverDyn [REDACTED] and that the lost sales associated with DOE transfers would be equally distributed among itself, Areva and Cameco. This amounts to 933 MTU per year, [REDACTED]. *Id.* at 5 n.3. ConverDyn then provides a table asserting that it would experience [REDACTED]. *Id.* at 4–5.

In addition to the above, ConverDyn notes in its RFI comment that the Metropolis Works facility ceased production beginning in January 2015 for a period of approximately three months. The facility apparently stops operating on an annual basis for maintenance and upgrades, but ConverDyn states that the pause is ordinarily only one month long. ConverDyn states that the longer shutdown was necessitated by ''the continued depressed state of the conversion market.'' Although ConverDyn refers to the displacement of conversion sales by DOE's transfers, it acknowledges that DOE's transfers are not the sole cause of the lengthening of Metropolis Works facility's annual shutdown. ConverDyn does not include supporting data or otherwise provide a proportionate breakdown of the impact of DOE material versus other factors in causing this shutdown. RFI Comment of ConverDyn, Enclosure, at 4.

The UxC Report does not provide estimates for production levels or production costs at individual facilities, but its report does note that the cost for primary producers is ''known to be in the range of $10–$15/kgU.'' UxC Report, 15. In a separate publication, UxC provides more detailed estimates of both current production levels and projected future production for individual facilities. Market share can be determined by comparing production levels to those of other primary producers and secondary sources. UxC Conversion Market Outlook—December 2014, 45–47 (2014). Notably, UxC's estimates of production at MTW [REDACTED]. *Id.* at 47. [REDACTED].[99] *Id.* at 46. [REDACTED]. *Id.* at 48.

[95] The analysis below differs from the discussion above regarding production by the domestic mining industry. The two industries and markets have different characteristics. With respect to mining, the presence or absence of DOE transfers is expected to result in a small change in uranium prices. The result of a price increase or decrease would be to motivate a production increase or decrease, respectively, by the producers with marginal costs in the relevant range. By contrast, as discussed below, converters generally have relatively low variable costs. DOE estimates that ConverDyn's marginal cost is substantially lower than the current spot price for conversion. Thus, changes in price do not motivate production in the same way as in the uranium markets, and a different approach is warranted for estimating production changes.

[96] A version of this table appeared as Table 7 in Section III.B.3 of the Department's March 18, 2015, Notice of Issues for Public Comment. 80 FR 14,119. The figures in that table and accompanying text were slightly different from those found in the 2015 ERI Report. This version of the table includes the correct figures from page 68–70 of the 2015 ERI Report. This difference between the two sets of figures is minimal.

[97] ConverDyn states that any economic model should analyze actual sales data including both historic and forward sales. RFI Comment of ConverDyn, Enclosure, at 2. To the extent that such data has been provided to DOE through responses to the RFI, NIPC, and ConverDyn's March 10, 2014 letter, this analysis considers those data. However, if the suggestion is that no economic model constructed without such data is reasonable, DOE does not agree.

[98] ConverDyn suggests that it believes DOE is requesting or requiring it to submit specific information. NIPC Comment of ConverDyn, Enclosure, at 1–2. To the contrary, DOE is merely describing its assumptions and its reasoning. In some respects DOE has made use of information that ConverDyn provided, and on some points DOE has used other inputs. It is appropriate for DOE to consider, in making factual inferences, whether a given inference is consistent with information provided by ConverDyn, conflicts with a submission, or is made in the absence of information from ConverDyn.

[99] UxC's figures for worldwide supply include both primary production and secondary supplies from sources such as re-enrichment of tails and

Traxys provides some information relevant to DOE's assessment of the likely impact its transfers will have on production by the domestic conversion industry. Traxys explains that in selling material obtained from Fluor-B&W Portsmouth, it pursues a goal to sell at least 50% of the material to non-U.S. customers. Traxys states that it has consistently met this goal. RFI Comment of Traxys, at 1. Traxys further explains that in 2014 no more than 40% of DOE-derived material was sold in the U.S. market. RFI Comment of Traxys, at 2.[100] This is similar to the amount of conversion that Traxys has separately stated went to the U.S. market in prior years. Traxys stated in July 2014 that 42% of DOE-derived conversion entered the U.S. marketplace during calendar year 2013. Declaration of Kevin P. Smith, *ConverDyn* v. *Moniz,* Case no. 1:14–cv–01012–RBW, Document 17–7 at ¶11 (July 7, 2014).

MTW's actual production has fluctuated dramatically in recent years, ranging from 4.5 to 11 million kgU, for a number of reasons including work stoppages due to labor disputes, shutdowns imposed by MTW's safety regulator, and plant upgrades as well as possibly competition with other sources of conversion. The scale of those fluctuations, and of the associated financial consequences, makes it difficult to identify an amount of reduced production that could reasonably be attributed to DOE's past transfers—an analytical step that would otherwise help inform DOE's forecast of the effect of future transfers on MTW's production. In what follows, DOE will apply basic economic principles to information gleaned from ConverDyn and other sources to make that evaluation.

ConverDyn offers a scenario in which DOE transfers at 2,800 MTU per year would cause ConverDyn to lose sales of 933 MTU per year. Letter from Malcolm Critchley, ConverDyn, to Peter B. Lyons, DOE, 4–5 (Mar. 10, 2014); *see also* Supplemental Declaration of Malcolm Critchley, *ConverDyn* v. *Moniz,* Case no. 1:14–cv–01012–RBW, Document 21–2, at ¶ 7 (July 14, 2014). DOE does not believe that ConverDyn's estimate that it would lose volume of 933 MTU per year is accurate. ConverDyn estimated that loss by reasoning that each of three Western conversion providers—*i.e.* not those providers in Russia or China—would experience volume losses equal to one third of the amount of DOE transfers (at the old 2,800 MTU per year rate). That analysis is overly simplistic. As ERI explains, approximately one third of DOE-sourced uranium is distributed in the world outside the United States, whereas ConverDyn's U.S. sales generally represent more than a third of its recent production. Assuming that ConverDyn's domestic market share is 25%, or 4.5 million kgU, data from UxC indicate that approximately [REDACTED] would be devoted to U.S. sales. UxC Conversion Market Outlook—December 2014, 45–46 (2014). The relative volume loss to the different converters should depend on the relative proportions of each converter's production that ends up on the U.S. versus world market. It seems unlikely that the three converters have identical market shares in the various world markets. Thus, all else being equal, one would not expect ConverDyn to have the same volume loss as its peers elsewhere.

ERI's analysis takes account of this difference in market share between the U.S. and the rest of the world. DOE believes that ERI's approach to estimating lost sales volume based on market share is reasonable.[101] However, ERI's estimate assumes that ConverDyn's production volume will be 8.25 million kgU in 2015. Based on other available information, DOE believes that that both sales and production at MTW are significantly higher. Specifically, ConverDyn has provided information about sales, and UxC estimates and forecasts MTW's production. ConverDyn's March 10, 2014 Letter suggested [REDACTED]. Letter from Malcolm Critchley, ConverDyn, to Peter B. Lyons, DOE, 5 n.3 (Mar. 10, 2014). Similarly, UxC estimates [REDACTED]. UxC Conversion Market Outlook—December 2014, 46 (2014). Applying ERI's approach to this higher estimate of MTW production, DOE concludes that as a consequence of DOE transfers under the assessed case, MTW can be expected to experience a reduction in production volume of about 700,000 kgU in 2015, and 600,000 kgU in 2016 and 2017.[102]

In addition to the above effects, ConverDyn's March 10, 2014, letter also refers to [REDACTED]. Letter from Malcolm Critchley, ConverDyn, to Peter B. Lyons, DOE, 5–6 (Mar. 10, 2014). DOE believes that these [REDACTED]. ConverDyn acknowledges that this may be the case [REDACTED]. *Id.* at 5 n.3. [REDACTED]. [REDACTED] on the basis of the total price gap between term and spot prices, which is about $8.50 per kgU. As discussed above, DOE's best estimate of the price effect under the assessed case is a suppression of about $0.80. That amount represents about 9% of the current gap between the spot and term prices.

b. Production Costs

Based on the estimates of the effect of DOE transfers on ConverDyn's production volume, ERI also estimated the change in average per unit production costs that a volume decrease would cause. ERI's approach to calculating this effect is straightforward. Average per unit production cost can be calculated by dividing the total production cost by the number of units produced. If MTW's costs were 100% variable, then average production costs would not change, regardless of the volume produced. However, if some portion of MTW's costs are fixed, then a decrease in the number of units produced would lead to increased production costs, and vice versa. If the proportion of fixed costs, current production volume, and current per unit production cost are all known, the change in average production cost can be easily calculated. ERI looked to various public sources and estimates to provide a basis for its assumptions. DOE believes that this a reasonable approach for estimating the effect of DOE transfers on production cost at MTW.

As discussed above, ERI estimates that ConverDyn's current sales volume is 8.25 million kgU. This estimate is based on ConverDyn's statements about prior production levels at MTW and a stated 25% decrease in volume associated with the Fukushima accident. 2015 ERI Report, 65. ERI then estimates that MTW's current average per unit production cost is $15 kgU. This cost is primarily based on ConverDyn's claim that it has lost more than $100 million in the past decade. Finally, ERI analyzed two scenarios

underfeeding. [REDACTED]. UxC Conversion Market Outlook—December 2014, 46 (2014).

[100] Traxys also states that it purchased additional conversion in 2014 above and beyond what it purchased from Fluor B&W Portsmouth. Traxys suggests that these purchases ''offset'' an equivalent of DOE-introduced quantities. RFI Comment of Traxys, at 1. As far as DOE is aware, these purchases are unrelated to its transfers of natural uranium hexafluoride to FBP. Thus, DOE does not treat these purchases as ''offsetting.''

[101] ConverDyn urges DOE to consider the effects of prior uranium inventory transfers in assessing the reduction in demand and sales volume. DOE believes that for transfers for Portsmouth cleanup and down-blending services, any displaced sales volume will take place in the year of transfer. However, DOE agrees that certain prior transfers have effects in the market several years after the actual transfer, and it has taken these effects into account.

[102] This calculation assumes MTW production volumes in line with UxC's base case primary conversion supply estimate for 2015, 2016, and 2016. UxC Conversion Market Outlook—December 2014, 46 (2014). Specifically, UxC estimates [REDACTED]. *Id.*

assuming fixed costs make up 80% or 100% of MTW's total production costs. ERI states that these assumptions are based on the fact that conversion facilities in general have fairly high fixed costs relative to variable costs. 2015 ERI Report, 71.

DOE believes that ERI's estimate of production cost at $15 per kgU is reasonable. This appears to be a conservative estimate because it falls at the upper end of UxC's estimate, and because it is about as high as production costs could be for ConverDyn to have a viable business at the price point it set by its own announcement in 2010 and 2011. In addition, ConverDyn has not disputed ERI's estimate of MTW's production costs.

However, as stated above, based on ConverDyn's statements and estimates from UxC, DOE believes MTW's current production volume is higher than 8.25 million kgU. Thus, ERI's estimate of MTW production volume appears to be an underestimate. In addition, DOE believes that ConverDyn's fixed costs are somewhat lower than 80%. ConverDyn has not provided details of its cost structure, but it has provided information that is consistent with ERI's analysis while suggesting that ERI overestimated ConverDyn's fixed costs. ConverDyn offers a scenario in which DOE transfers at 2,800 MTU per year would cause ConverDyn to lose sales of 933 MTU per year. The company says that decrease in volume would result in [REDACTED]. Letter from Malcolm Critchley, ConverDyn, to Peter B. Lyons, DOE, 4–5 (Mar. 10, 2014). ConverDyn's fixed costs would not change if ConverDyn lost sales, so the change in profit would be due to the decrease in revenues, offset by the elimination of the variable costs that would have been incurred to produce the lost volume. *See* Supplemental Declaration of Malcolm Critchley, *ConverDyn* v. *Moniz,* Case no. 1:14–cv–01012–RBW, Document 21–2, at ¶ 7 (July 14, 2014). The revenue decrease from losing 933 MTU in volume would be about $14.9 million. [REDACTED].[103] Assuming MTW has production costs of $15 per kgU and MTW's variable costs are [REDACTED], then fixed costs at MTW should be [REDACTED]. This represents about [REDACTED] of total costs. DOE adopts this estimate of ConverDyn's variable costs, because it is based on information ConverDyn has provided.

DOE has performed an analysis like ERI's, using the different assumptions discussed above. Specifically, this calculation uses $15 per kgU as MTW's current production cost, [REDACTED] as the proportion of fixed cost, and UxC's base case primary conversion supply estimate of MTW's production volume as MTW's production volume with DOE transfers [104]—namely[REDACTED]. UxC Conversion Market Outlook—December 2014, 46 (2014). Based on these inputs, DOE concludes that transfers in the assessed case would increase MTW's average production cost by $0.63 in 2015, $0.49 in 2016, and $0.45 in 2017.

DOE does not believe this increase indicates an adverse material impact. In recent years MTW has experienced several significant disruptions in its business that are not attributable to DOE transfers. These disruptions have caused MTW's annual production to vary significantly—from as high as 11 million kgU to as low as 4.5 million kgU, the latter figure representing less than a third of MTW's nameplate capacity. DOE notes that the predicted decrease in volume reasonably attributable to DOE—*i.e.* 700,000 kgU in 2015 and 600,000 kgU in 2016 and 2017—and the associated decrease in MTW's average production cost, are substantially smaller than the production decreases at MTW from these other disruptions. The production swings experienced at MTW in recent years have been as much as seven times the magnitude of the sales volume decreases attributable to DOE.

Moreover, the conversion industry has maintained term prices at around $16 per kgU notwithstanding those fluctuations. As discussed above, converters seem able to demand, and conversion purchasers seem willing to accept, prices high enough to cover production costs and justify the investment to maintain conversion capacity. As average production costs increase over time—which they will do even absent DOE's transfers—it seems likely the prices of term contracts will keep pace.

3. Employment Levels in the Industry

ERI notes that Metropolis Works restarted after an extended shutdown in summer 2013 with approximately 270 employees. Prior to the 2012–2013 shutdown, ERI estimates that the facility employed approximately 334 people. As this change coincided with a change in long-term production volume, ERI concludes that it is unlikely that 100% of Metropolis Works' production costs are fixed. 2015 ERI Report, 72–73. Although it does not provide specific estimates, ERI states that ''[a] portion of the reduction in work force at Metropolis Works may be associated with the introduction of DOE inventory into the market.'' However, ERI also notes that several other factors likely played a part as well. 2015 ERI Report, 73. ConverDyn does not provide a separate estimate of decreased employment levels due to DOE transfers; instead ConverDyn referred to the relevant sections of the 2014 ERI Report, which reaches conclusions similar to those in the 2015 ERI Report. RFI Comment of ConverDyn, Enclosure, at 5.

The Department recognizes that employment at the MTW facility is lower than in prior years. Little of this decrease can reasonably be attributed to DOE transfers. While some portion of MTW's labor force is a fixed cost that does not depend on volume, DOE estimates the maximum amount of decrease attributable to DOE transfers by assuming all employment at ConverDyn and MTW varies directly with production. As discussed above, DOE forecasts that transfers under the assessed case will reduce MTW's production by 700,000 kgU in 2015 and 600,000 kgU in 2016 and 2017, or 7% of expected 2015 production and 5% expected production in 2016 and 2017. Assuming all of ConverDyn's current labor force is fully variable with production, the employment decrease reasonably attributable to DOE transfers in futures years would be approximately 19 person-years in 2015, 14 person-years in 2016, and 13 person-years in 2017. Of course, the assumption that labor is fully variable is likely to be quite conservative, and it is more likely that a substantial portion of the labor force is a fixed cost. If 50% of labor costs are variable, this would result in a reduction of 9 lost person-years in 2015 and 7 lost person-years in 2016 and 2017. As with comparable analyses discussed above, these figures represent a persistently lower employee count; DOE is not forecasting that every year ConverDyn will lose an additional 7 to 19 employees.

[103] DOE assumes that ConverDyn's calculation is based on the loss of sales at the prevailing term price in March 2014, *i.e.* $16.00 per kgU. DOE recognizes that there are actually two mechanisms by which ConverDyn may lose sales. [REDACTED] Letter from Malcolm Critchley, ConverDyn, to Peter B. Lyons, DOE, 5 n.3 (Mar. 10, 2014). To the extent that some reduced sales come from this latter category, [REDACTED]. Given that term prices have remained relatively steady for the past several years, DOE does not believe the difference would be significant for the purposes of this analysis.

[104] UxC's conversion market outlook bases these estimates based on current market conditions. As described above, DOE believes that the ConverDyn's current sales volume should reflect a level of transfers at 2,705 MTU per year. DOE notes that this is somewhat higher than the assessed case. Thus, MTW's production volume in future years should be slightly higher due to this reduction. DOE does not believe this difference is significant enough to markedly change this calculation.

A reduction in employment of 7 or even 19 person-years is relatively small, particularly in comparison to MTW's reduction of approximately 64 after the 2012–2013 shutdown. The industry has been able to weather employment losses much larger than any that could reasonably be attributed to DOE transfers.

4. Changes in Capital Improvement Plans and Development of Future Facilities

Although there are several large-scale development projects currently planned or underway outside the United States—namely AREVA's COMURHEX II modernization project and TVEL's plan for a new facility at SCC—DOE is not aware of any such plans in the United States. *See* Eileen Supko & Thomas Meade, ''New facilities are on the horizon,'' *Nuclear Engineering International* (Oct. 6, 2014), available at *http://www.neimagazine.com/features/featurenew-facilities-are-on-the-horizon-4394892*; UxC Conversion Market Outlook—December 2014, 50, 56–57, 73 (2014).[105]

Metropolis Works has, however, undertaken substantial capital expenditures at its existing facility in recent years. Honeywell has stated that it has invested ''nearly $177 million over the past 10 years in capital improvements, including $50 million in safety projects.'' ''About Us,'' Honeywell, *http://www.honeywell-metropolisworks.com/about-us*.[106] Some of these upgrades came during an extended shutdown in 2012 and 2013, in which Metropolis Works made upgrades to ensure the facility could withstand extreme natural disasters. These changes were made under an agreement with the U.S. Nuclear Regulatory Commission (''NRC'') in response to an inspection NRC conducted in the wake of the Fukushima disaster in Japan. ''Honeywell and U.S. Nuclear Regulatory Commission Reach Agreement on Necessary Upgrades to Metropolis Nuclear Conversion Facility,'' News Release (Oct. 16, 2012), available at *http://www.honeywell-metropolisworks.com/?document=oct-16-2012-press-release-honeywell-and-u-s-nuclear-regulatory-commission-reach-agreement-on-necessary-upgrades-to-metropolis-nuclear-conversion-facility&download=1.*

In terms of current plans, Metropolis Works announced in November 2014 that it would be shutting down for approximately 90 days beginning in early January 2015. Honeywell noted that it would use the extended shutdown to make updates and capital improvements. Jim Pritchett, Honeywell Metropolis Works, Letter to Employees (Nov. 20, 2014), available at *http://www.honeywell-metropolisworks.com/?document=letter-to-employees-23&download=1*; *see also* Comment of ConverDyn, Enclosure, at 4. Honeywell has further stated that the company plans to spend $17.5 million in improvements during 2015. Jim Pritchett, Honeywell Metropolis Works, Letter to Employees (Jan. 30, 2014), available at *http://www.honeywell-metropolisworks.com/?document=letter-to-employees-24&download=1*. Honeywell recently announced that MTW would restart production on or about April 1, 2015. Honeywell Metropolis Works, News Item (Mar. 27, 2015), *http://www.honeywell-metropolisworks.com/news/* (accessed Mar. 31, 2015).

With the expected increase in demand for conversion services worldwide, DOE believes that it is likely that MTW will continue to make capital improvements and refurbishments necessary to maintain current capacity. Honeywell has invested a substantial amount in such capital improvements in recent years. UxC reports that [REDACTED]. UxC Conversion Market Outlook—December 2014, 70 (2014). ConverDyn's comments agree with that proposition; ConverDyn indicates that it is not planning to expand capacity but does intend to maintain its capacity. NIPC Comment of ConverDyn, Enclosure, at 7.

DOE does not believe that the price effect associated with DOE transfers would make a significant difference in plans for new facilities or other capital improvements at existing facilities. As described above, the term price, at which the vast majority of capacity is transacted, appears to respond weakly to changes in supply. DOE transfers are expected to decrease ConverDyn's sales volume, but even without DOE transfers, ConverDyn's total sales would still be below MTW's current maximum nameplate capacity. In addition, transfers under the assessed case will represent only about 3% of total supply in coming years, and about 11% of secondary supply. In light of forecasts of supply and demand by ERI and UxC, DOE concludes that eliminating this amount of conversion would not make a difference to the assessment that new capacity is not warranted.

5. Long-Term Viability and Health of the Industry

ERI's most recent Reference Nuclear Power Growth forecast predicts global requirements for conversion services will grow to approximately 67.2 million kgU by 2020, approximately 20% higher than current requirements. Global requirements are expected to continue to rise to a level of 91.4 million kgU by 2035, approximately 63% higher than current requirements. 2015 ERI Report, 13.[107] ERI presents a graph comparing global requirements, demand, and supply from 2013–2035. Global secondary supply and supply from primary converters are expected to exceed global demand until at least 2025. Beyond that point, supply is forecast generally to keep pace with growth in requirements. 2015 ERI Report, 14.

Although not focused on conversion, the requirements forecasts noted above in Section IV.A.5 are also relevant to the conversion industry. In general, requirements and/or uranium concentrate demand forecasts should also apply to demand for conversion services.[108] However, there may be some small differences due to strategic and discretionary inventory building. For example, China has been purchasing strategic supply well in excess of its requirements. Those purchases have come in the form of U_3O_8. 2015 ERI Report, 13. Thus, these purchases affect near-term uranium concentrate demand, but do not affect near-term conversion demand.

In its December 2014 Conversion Market Outlook, UxC predicts significant increases in both

[105] ConverDyn states that large-scale projects outside the United States are immaterial. NIPC Comment of ConverDyn, Enclosure, at 7. Consistent with the analytical approach described above, DOE's task is to forecast the state of the domestic uranium conversion industry with and without DOE transfers under the assessed case. However, DOE believes activities in the global conversion industry may in some cases be relevant for predicting how DOE transfers will affect the domestic conversion industry.

[106] Letters from Honeywell management include similar numbers. A November 20, 2014, letter included identical figures. Jim Pritchett, Honeywell Metropolis Works, Letter to Employees (Nov. 20, 2014), available at *http://www.honeywell-metropolisworks.com/?document=letter-to-employees-23&download=1.* Older letters provided slightly different figures. Jim Pritchett, Honeywell Metropolis Works, Letter to Community (Dec. 19, 2013), available at *http://www.honeywell-metropolisworks.com/?document=letter-to-the-community-from-new-metropolis-works-plant-manager&download=1.*

[107] ERI's reference requirements include anticipated future reactor shutdowns, both in the United States and elsewhere, due to reasons such as competition with natural gas and other energy sources.

[108] ConverDyn suggests that forward demand from Japanese reactors should be assumed to be zero until at least 2018. As stated above, the requirements and demand outlooks of TradeTech predict growth in demand despite planned reactor shutdowns in Germany and decreased demand from Japan. It also appears that UxC projections account for decreased demand from Japan as well.

requirements and demand in the long-term. UxC Conversion Market Outlook—December 2014, 40, 44 (2014). Specifically, [REDACTED]. *Id.* at 44. In the longer term, [REDACTED]. *Id.* UxC projects that conversion supply [REDACTED]. *Id.* at 46. [REDACTED]. *Id.* at 47.

UxC also provides a more detailed explanation of its price forecast, which generally predicts an increase in price over the next 10 years. UxC Conversion Market Outlook—December 2014, 82, 85 (2014). [REDACTED]. *Id.* at 82. [REDACTED]. *Id.* at 75. UxC provides a separate forecast for the term price. [REDACTED]. *Id.* at 85. UxC also notes that some market participants [REDACTED]. *Id.* at 73.

Finally, as with uranium concentrates, DOE recognizes that the predictability of transfers from its excess uranium inventory over time is important to the long-term viability and health of the uranium conversion industry. Again, DOE notes that the upper scenario considered by ERI would represent continued transfers at rates consistent with the May 2012 and May 2014 determinations. Compare 2015 ERI Report, 25, with 2014 ERI Report, 28.

As described above, demand is expected to increase substantially in the next several years. Along with it, as the existing conversion facilities age, additional capital improvement for refurbishments will be required. Even with these refurbishments, eventually, new conversion capacity will be necessary to match increasing demand. Given that demand in North America is not expected to decrease substantially and that enrichment capacity is expected to increase, it is likely that the domestic uranium conversion industry will retain its capacity, either through continuing refurbishments at MTW or through the development of one or more new conversion facilities.[109]

Although DOE transfers may not have a large effect on the conversion term price, displaced production volume increases average production costs for primary producers. DOE does not believe this effect will be large enough to significantly alter planned decisions about conversion capacity in the United States. At worst, as with the uranium mining industry, the effect of DOE transfers would be to shift major capital improvements later in time. DOE does not believe that this difference is significant enough to appreciably affect the long-term viability and health of the domestic uranium conversion industry.

ConverDyn has submitted, on several occasions, figures for losses it says it has suffered in the recent past. These figures vary. ConverDyn stated in its March 10, 2014 letter that [REDACTED]. Letter from Malcolm Critchley, ConverDyn, to Peter B. Lyons, DOE, 1 (Mar. 10, 2014). In addition, ConverDyn asserts that it is a marginal business, by which it appears to mean that it is only barely viable. There is some tension between these assertions, together with the fact that MTW has continued to invest substantial amounts of money to maintain and upgrade the facility, most recently in the beginning of 2015. In any case, many causes have contributed to ConverDyn's financial results. Those causes include, among others, the consequences of the Fukushima disaster[110] and the various production stoppages MTW has experienced. Indeed, some of the losses ConverDyn has cited predate any substantial DOE transfers of uranium hexafluoride. As explained above, DOE bases its determination on an analysis of what the state of an industry would be with DOE transfers as compared to its state without transfers, and an assessment of what impacts can reasonably be attributed to the transfers. ConverDyn's submissions do not include such an analysis that would attribute some portion of the losses to DOE's transfers. They therefore do not call into question the economic analysis described above.

6. Russian HEU Agreement and Suspension Agreement

Section 3112(d) of the USEC Privatization Act requires DOE to ''take into account'' the sales of uranium under the Russian HEU Agreement and the Suspension Agreement. As discussed above, DOE believes this assessment should consider any transfers under these two agreements that are ongoing at the time of DOE's transfers.

Under the Russian HEU Agreement, upon delivery of LEU derived from Russian HEU, the U.S. Executive Agent, USEC Inc., was to deliver to the Russian Executive Agent, Technabexport (Tenex), an amount of natural uranium hexafluoride equivalent to the natural uranium component of the LEU. DOE notes that the Russian HEU Agreement concluded in December 2013. Thus, there are no ongoing transfers under this agreement.

The current iteration of the Suspension Agreement, described above in Section I.D.3.b, sets an annual export limit on natural uranium from Russia. 73 FR 7705 (Feb. 11, 2008). That agreement provides for the resumption of sales of natural uranium and SWU beginning in 2011. While the HEU Agreement remained active (*i.e.* 2011–2013), the annual export limits were relatively small— equivalent to between 170,000 and 410,000 kgU as UF_6. After the end of the Russian HEU Agreement, restrictions range between an amount equivalent to 4,540,000 and 5,140,000 kgU as UF_6 per year between 2014 and 2020. 73 FR 7705, at 7706 (Feb. 11, 2008). Material imported from Russia in accordance with the Suspension Agreement is not derived from down-blended HEU; thus, this material is part of worldwide primary supply as analyzed by ERI in the 2015 ERI Report.[111] This material is also presumably accounted for in the various projections and models developed by TradeTech and UxC. Thus, DOE's analysis takes those sales that have a conversion component under the Suspension Agreement into account as part of overall supply available in the market.

7. Conversion Industry Conclusion

After considering the six factors as discussed above, DOE concludes that transfers under the assessed case will not have an adverse material impact on the domestic uranium conversion industry. MTW and ConverDyn, together the sole conversion provider in the United States, sell nearly exclusively on term contracts. As explained above, DOE transfers will not affect the term price at which those contracts are transacted. DOE transfers under the assessed case will contribute to the spot price a continued $0.70–$0.80 suppression, a somewhat smaller effect than transfers in the past few years have had. Because only a very small proportion—if any—of MTW's sales take place at the spot price, that price suppression will not be material for the domestic industry.

In addition, DOE forecasts that over time, MTW's production will be smaller

[109] ConverDyn suggests that Russian, Chinese, and Indian demand should be excluded because these markets are closed to sales from the domestic conversion industry. DOE notes that even if North American converters lack access to these markets, converters in those countries have access to markets worldwide. ConverDyn does not contest the notion that conversion is essentially a global commodity. Thus, increased demand in Russia, China, and India will consume capacity with which ConverDyn would otherwise compete in markets that it can access.

[110] ConverDyn further states [REDACTED]. Letter from Malcolm Critchley, ConverDyn, to Peter B. Lyons, DOE, 4 (Mar. 10, 2014). [REDACTED].

[111] ERI states that it assumes 80% of the material supplied under the Suspension Agreement includes a conversion component. ERI further states that it believes Rosatom would not have a market for these included conversion sales without the Suspension Agreement. 2015 ERI Report, 83. In any case, it appears that ERI's analysis includes this material as part of the overall conversion supply.

than it would have been in the absence of DOE transfers by 700,000 kgU in 2015 and 600,000 kgU in 2016 and 2017. DOE conservatively estimates such a reduction would increase MTW's average production costs by about $0.63 in 2015, $0.49 in 2016, and $0.45 in 2016. DOE does not believe this change would constitute an adverse material impact, within the meaning of section 3112(d), because it is well within the range of production changes that MTW has experienced in recent years independent of DOE transfers. The reduced production may also lead to a decrease in employment, but DOE expects that decrease to be no more than a persistent 19 person-years in 2015 and 14 person-years thereafter, a smaller change than what MTW has implemented on its own in ordinary business decisions.

Honeywell, the owner and operator of MTW, continues to invest in maintaining and refurbishing the MTW facility, and DOE transfers seem unlikely to change those plans. ConverDyn claims that MTW is on the verge of collapse. If that is so, DOE does not believe that MTW's state is reasonably attributable to DOE's recent transfers or that the dire outcomes ConverDyn predicts will reasonably be attributable to transfers under the assessed case.

DOE does not believe that any of the effects described for the domestic uranium conversion industry have the substantial importance that would make them ''adverse material impacts'' within the meaning of section 3112(d).

C. Uranium Enrichment Industry

The domestic uranium enrichment industry consists of a relatively small number of companies, one of which operates a currently operating enrichment facility and several of which are developing facilities expected to begin production in the near future. The Paducah Gaseous Diffusion Plant, which was operated by USEC Inc.—since restructured as Centrus Energy Corp.—closed in 2013. Centrus may still be selling SWU from its inventory of uranium enriched at that facility, but this material is finite. Thus, there is only one currently operating enrichment facility in the United States, the URENCO USA (UUSA) gas centrifuge facility in New Mexico.[112] DOE is also aware of three other planned enrichment facilities in Idaho, Ohio, and North Carolina.

The current capacity of the UUSA facility is 3.7 million SWU. For comparison, the World Nuclear Association reports that worldwide capacity in 2015 is approximately 61 million SWU. *See* WNA, ''Uranium Enrichment'' (Jan. 2015), *http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Conversion-Enrichment-and-Fabrication/Uranium-Enrichment/* (accessed Mar. 31, 2015).

1. Prices for Enrichment Services

Like market prices for uranium concentrates and conversion, enrichment market prices are generally described in terms of the spot price and the term price. This section discusses the potential impacts of DOE transfers on these two prices. For reference, as of March 30, 2015, UxC's spot price indicator is $79.00 per separative work unit (SWU) and its term price indicator is $90.00 per SWU.

Two of the market analyses discussed above contain estimates of the effect of DOE transfers on the market prices for conversion services: ERI and UxC. This section begins with a summary of each report and then discusses DOE's review of the reports' methodologies and conclusions. This section concludes with a discussion of how a change in conversion market prices would affect the domestic uranium enrichment industry. A principal mechanism through which such a change in market price could impact individual producers is through the effect on the realized price of primary enrichers.

a. Energy Resources International Report

In its analysis, ERI estimates the effect of DOE transfers on the market prices for enrichment services. To estimate this effect, ERI employed a market clearing price model similar to what is described above for the uranium and conversion markets. As with uranium concentrates and conversion, ERI constructed individual supply and demand curves for enrichment services and estimated the clearing price with and without DOE transfers. 2015 ERI Report, 44. The discussion in Section IV.A.1 regarding DOE's analysis of ERI's market clearing approach analysis also applies to ERI's estimates of the effect of DOE transfers on market prices for enrichment services. A summary of ERI's estimates of the effect of DOE transfers on the market price for SWU appears in Table 15.

As with uranium concentrates, DOE tasked ERI with estimating the effects of DOE transfers under the same three scenarios described in Section IV.A.1. The amounts of uranium entering the market at various times in different scenarios are outlined above in Table 4 in terms of MTU natural uranium equivalent.[113] Not all of the uranium under these scenarios includes an enrichment component—denominated in SWU. The amount of SWU that is necessary to produce the volumes contemplated under the different scenarios are listed in Table 14. For the LEU transferred for down-blending services, these figures are calculated assuming natural uranium feed, a tails assay of 0.20 wt-% U–235, and a product assay of 4.95 wt-% U235.[114] As with uranium concentrates, the assessed case falls somewhere between Scenarios 1 and 2 when calculated in terms of SWU.

TABLE 14—ENRICHMENT COMPONENT OF SCENARIOS CONSIDERED IN THIS ANALYSIS

Enrichment component of transfers for Portsmouth cleanup and down-blending in SWU			
	Portsmouth cleanup	Down-blending	Total
ERI Scenario 1	0	680,000	680,000
ERI Scenario 2	0	470,000	470,000
ERI Scenario 3	0	0	0
Assessed Case	0	520,000	520,000

[112] This facility is operated through Louisiana Energy Services, LLC, a subsidiary of Urenco Limited.

[113] As noted above, the transfer rates for these scenarios refer only to the level of uranium transfers for cleanup at Portsmouth and down-blending of LEU. Uranium transfers under other programs—*i.e.* blended LEU to TVA, depleted uranium hexafluoride to Energy Northwest, and the possible future transfer of depleted uranium hexafluoride to GE-Hitachi Global Laser Enrichment—are the same in all three scenarios.

[114] The ''natural uranium equivalent'' figures for material from down-blending listed in Table 4 are also based on these assumptions. The natural uranium equivalent is then adjusted to take account of the natural uranium required as diluent as part of the down-blending process—typically 10% of the total natural uranium equivalent.

Table 15 summarizes ERI's results. As with uranium concentrates, the relationship between the amount of transfers under each scenario and the price effect is essentially linear for each year ERI analyzed (2015–2024). Compare Table 3.8 to Table 4.3 of 2015 ERI Report, 25–26, 45. Thus, it possible to interpolate the price effect that ERI's analysis would predict for other levels of transfers. The estimated price effect for the assessed case is approximately $0.20 higher than ERI's estimates for Scenario 2. These interpolated values are included in Table 15.

TABLE 15—ERI'S ESTIMATE OF EFFECT OF DOE TRANSFERS ON URANIUM ENRICHMENT PRICES IN $ PER SWU

[Market clearing approach]

2015 ERI Report				
	ERI Scenario 1	ERI Scenario 2	ERI Scenario 3	Assessed case (interpolated)
2015	$5.90	$5.10	$3.20	$5.30
2016	3.80	3.00	1.10	3.20
2017	3.50	2.60	0.70	2.80
2018	4.70	3.90	2.00	4.10
2019	5.10	4.20	2.30	4.40
2020	4.90	4.00	2.10	4.20
2021	5.20	4.30	2.40	4.50
2022	4.60	3.70	1.80	3.90
2023	4.40	3.50	1.60	3.70
2024	2.80	1.90	0.00	2.10
Average (2015–2024)	4.50	3.60	1.70	3.80

As with uranium concentrates and conversion, it is important to emphasize that this is not a prediction that prices will drop by the specified amount once DOE begins transfers following a new determination. A level of price suppression consistent with the estimate for Scenario 1 would, on ERI's analysis, already be reflected to some extent in the current market price because DOE has been transferring uranium at that rate for some time. 2015 ERI Report, 44. The price suppression that ERI estimates would persist under Scenario 3 is largely ERI's estimate of the consequence of past DOE transfers, from which some of the uranium is still expected to be entering the market in future years.

b. UxC Report

UxC estimates past effects of DOE uranium transfers on the price of enrichment services using its proprietary U–PRICE and SWU–PRICE models and then uses those models to forecast the effects of continued transfers at the rates described in the May 2014 Determination. UxC Report, 5. As with its uranium concentrate estimates discussed above, UxC provides ''incremental'' and ''total impact'' figures. In UxC's models, continued transfers at a given rate have a cumulative effect, so that the change to prices increases over time. UxC's ''incremental approach'' estimates the effect of DOE transfers beginning in 2012. The ''total impact approach'' estimates the effect of DOE transfers beginning in 2008, so as, in UxC's view, to take full account of the cumulative effect of all transfers.

Using its incremental approach, UxC estimates that between 2012 and 2014 DOE's transfers reduced the spot price by an average of $7.49 per SWU and the term price by an average of $5.37 per SWU. Using its total impact approach, UxC estimates that DOE's transfers between 2008 and 2014 reduced the spot price in the period from 2012 to 2014 by an average of $9.19 per SWU and the term price by an average of $6.96 per SWU. UxC Report, 8–9.

UxC also forecasts the effect of DOE's continuing transfers at current rates for the period 2015 to 2030. A summary of UxC's estimates of the effect of DOE transfers on future enrichment prices appears in Table 16. UxC estimates that DOE transfers in the near and medium terms would reduce the spot price by an average of $5.31 per SWU. UxC projects that this effect will change slightly in the medium term as market prices start to recover. Specifically, DOE transfers would reduce the spot price between 2018 and 2030 by an average of $4.86 per SWU. UxC also notes that the former number is larger relative to the expected price of enrichment than the latter number (5.9% versus 3.8%)—both, DOE surmises, because the longer-term price effect is smaller, and because the longer-term price is higher. UxC Report, 12. UxC forecasts that DOE transfers in the near and medium terms would reduce the term price by an average of $5.50 per SWU. Between 2018 and 2030, UxC forecasts that DOE transfers would reduce the term price by an average of $5.00 per SWU. Again, the near and medium term impact is larger in relation to the expected price (5.6% versus 3.6%). UxC Report, 11.

TABLE 16—UXC'S ESTIMATE OF EFFECT OF DOE TRANSFERS ON ENRICHMENT SPOT AND TERM PRICES IN $ PER SWU

UxC Report		
	Near- & mid-term price effect	Long-term price effect
Spot Price	$5.31	$4.86
Term Price	5.50	5.00

c. Effect of DOE Transfers on Market Price

After reviewing the market analyses described above, and other information including other comments received, DOE concludes that ERI's method for estimating and forecasting the price effects reasonably attributable to DOE's transfers is reasonable. As explained above, the market-clearing price analysis is consistent with basic economic principles and should be a reasonable way to estimate relatively small changes in price, assuming the market has a competitive price-setting mechanism. It is not clear whether the enrichment market functions in that way. The market is even more concentrated than the conversion market: Only four companies worldwide provide enrichment services, and one provides services essentially exclusively to Chinese purchasers. Unlike uranium and conversion, the enrichment market does not include significant sources of secondary supply.[115] On the other hand, buyers may be more sensitive to enrichment prices, both because enrichment constitutes a larger portion of the total cost of enriched uranium product and because natural uranium can be substituted, in the ''underfeeding'' sense described above, with uranium.[116] DOE observes that enrichment prices have been more variable than conversion prices and nearly as variable as uranium prices. For example, while enrichment prices did not drop immediately after the Fukushima incident, as uranium spot prices did, they have decreased by about 45% since 2011. Finally, there is not a large gap between spot and term prices for enrichment, as there is for conversion.

To be conservative, DOE will assume that a competitive price-setting mechanism does determine enrichment prices. On that assumption, ERI's market-clearing analysis should provide an appropriate forecast for the effects of DOE's transfers. To the extent that enrichment prices are uncompetitive, the price effect will tend to be smaller than what ERI forecasts.

Also, DOE notes that ERI's analysis assumes demand for enrichment to be perfectly inelastic. This assumption is a reasonable approximation, because, as discussed above, nuclear utilities have predictable requirements that must be filled. In reality, demand may have some small degree of elasticity. That elasticity would also tend to make the price effect smaller than what ERI forecasts.

However, as noted above, ERI's model does not take account of the interplay between uranium concentrates and enrichment prices. As explained above, for the uranium concentrates market, DOE expects that this interplay is not large enough to make a significant difference to this analysis. With respect to the enrichment market, DOE notes that only about one quarter of DOE's future transfers under the assessed case will displace enrichment services. Consequently, the effect of DOE's transfers on uranium hexafluoride prices should generally be larger than the effect on enrichment prices. Both ERI and UxC forecast such a relative difference—about 7% for concentrates for a rate of 2,705 MTU per year, compared to about 4% for enrichment. The amount of enrichment currently devoted to underfeeding depends in part on the relative prices of natural uranium hexafluoride and enrichment. If uranium prices decrease by a relative 3%, enrichers can be expected to devote less primary supply to underfeeding—on the order of 3% less, or about 200,000 SWU given that enrichers currently use about 8 million SWU for underfeeding. This is close to 40% of the total amount of SWU from DOE transfers under the assessed case.

UxC's model takes these interactions into account. DOE further notes that UxC's forecast of the effect on SWU prices is quite similar to ERI's, although it predicts a slightly larger effect on the price. UxC analyzed transfers that are equivalent to ERI's Scenario 1. Whereas ERI forecasts a price effect in the near term (2015–2017) of $4.40 for Scenario 1, UxC forecasts a near-term price effect of $5.31 (spot) or $5.50 (term). ERI forecasts a longer-term effect averaging $4.50 over the next decade. By comparison, UxC forecasts an effect of $4.86 (spot) or $5.00 (term).

While UxC did not provide forecasts for other possible transfer rates, it is reasonable to assume the price change would be proportional to the market displacement for supply changes that, like DOE's, constitute small proportions of total supply and have small effects on price. Accordingly, DOE concludes that UxC's model would forecast, for transfers under the assessed case, price effects of $4.55 (spot) or $4.70 (term) in the near-term and $4.15 (spot) or $4.30 (term) in the longer term.[117] DOE does not place much weight on UxC's forecast because, as discussed above, UxC's model relies on subjective exogenous variables such as ''market participants' general perception of the industry outlook'' and ''changes in market psychology'' that UxC sets prior to running its model in order to define the scenario that the model will predict.

However, DOE does believe that the consistency between UxC's forecast and ERI's indicates that the effect of interactions between the uranium and enrichment markets is unlikely to be larger than what DOE estimates here. Because the forecast price effects are only estimates, not precise to the penny, and because the underlying assumptions of ERI's model are reasonable, DOE concludes it is appropriate to rely on ERI's model with a revision to account for underfeeding. Accordingly, DOE adjusts the resulting estimate upward by 40% to reflect the additional enrichment supply that may become available due to the relative changes in uranium and enrichment prices.[118] Based on the above, DOE forecasts that transfers under the assessed case will continue to exert some downward pressure on the market prices for enrichment services, ranging from around $5.25 in the near term and $5.40 over the longer term.

The significance of price suppression at this level depends, at least in part, on market price. The 2015 ERI Report relies on the price indicators for SWU published by TradeTech on January 31, 2015. The spot price for SWU has decreased by about $9.00 since that date. The current price indicators, as published by UxC, are $79.00 per SWU in the spot market and $90.00 per SWU in the term market.[119] Thus, the estimated near-term price effect attributable to DOE transfers represents 6.7% and 5.9% of the spot and term

[115] In principle, overfeeding could generate surplus enrichment services just as underfeeding generates surplus natural uranium. At the prices prevailing in the recent past and anticipated in the near future, overfeeding would not be economical. Other sources of secondary supply in the uranium and conversion markets provide natural uranium, not enriched uranium. DOE's transfers for down-blending are secondary supply, but they constitute a much smaller portion of overall supply than total transfers do relative to uranium and conversion supplies.

[116] As noted elsewhere in this analysis, DOE believes the magnitude of any effect of DOE transfers on the uranium or enrichment price that is transmitted through the interaction with the enrichment or uranium price, respectively, is small. It is not inconsistent with that conclusion to believe that the interaction of the two prices could help limit the market's susceptibility to parallel pricing conduct.

[117] Transfers under the assessed case contain, on average, about 14% less SWU per year than the prior transfer rate.

[118] DOE notes that the additional suppression in enrichment prices would itself affect the interaction between the enrichment and uranium markets. Because that effect would tend push more enrichment capacity back to underfeeding, DOE believes it would at worst cause DOE's 40% adjustment to be an overestimate.

[119] URENCO states that the term enrichment price is currently $87.00 per SWU. NIPC Comment of URENCO, at 2. The most recent data available to DOE do not support this figure.

prices, respectively. Although it may be useful to compare the estimated price effect to current market prices for a sense of scale, comparing a longer term price effect to current market prices can be somewhat misleading; it is more appropriate to compare the price effect in future years to forecasted market prices in those years.

In its annual Enrichment Market Outlook, UxC provides a detailed explanation of its price forecast, which generally predicts an increase in term prices over the next 10 years. UxC Enrichment Market Outlook—Q4 2014, 91–94 (2014). [REDACTED]. *Id.* at 94. UxC reports [REDACTED]. *Id.* at 74. In the mid-term, UxC projects that the term price for SWU [REDACTED]. *Id.* at 94. UxC does not provide a separate forecast for the spot price. *Id.* at 79.

Using these price forecasts, it is possible to project the estimated price effect in future years as a percentage of the expected market price. DOE predicts that the price effect reasonably attributable to DOE transfers under the assessed case will be around $5.25 in the near term, and then average approximately $5.40 between 2018 and 2024. As prices increase, this price effect will represent a smaller proportion of the then-prevailing market prices. Based on UxC forecasts, which DOE believes to be a reasonable expectation for future prices, the price effect will average approximately [REDACTED] of the term price in 2015–2017, and [REDACTED] between 2018 and 2024.

d. Effect on Realized Price

As with uranium concentrates and conversion, the principal mechanism through which a change in market price would impact the domestic uranium enrichment industry is through the effect on what prices an enricher actually receives for its services. The market prices published by TradeTech and UxC are based on information about recent offers, bids, and transactions, and are thus a snapshot of contracting activity at the time of the publication. Enrichment, like uranium concentrates and conversion, is primarily sold on long-term contracts. Consequently an enricher's actual revenues are somewhat insulated from short-run fluctuations in price.

There is only one currently operating enrichment facility in the United States, the UUSA gas centrifuge facility in New Mexico. No commenter provides information about the realized price achieved by URENCO or the effect of DOE transfers on that price. However, other sources provide some relevant information.

In recent years, the vast majority of SWU has been sold on the term market. UxC Enrichment Market Outlook—Q4 2014, 17, 20 (2014). UxC reports that approximately [REDACTED] SWU were sold through spot contracts in 2014. *Id.* at 19. UxC estimates that 2014 enrichment demand stood at approximately [REDACTED]. *Id.* at 38. Based on these figures, spot sales in 2014 accounted for [REDACTED] of total SWU demand. ERI estimates that more than 95% of enrichment requirements are covered under long-term contracts. 2015 ERI Report, 74. Long-term contracts for SWU typically last for 10 or more years, in some cases and in some cases 15 or more years. UxC Enrichment Market Outlook—Q4 2014, 100 (2014).

Current term contracting volume is much smaller than pre-2010 volumes. *Id.* at 9, 21. UxC reports that long-term contracting activity [REDACTED]. *Id.* at 20. [REDACTED]. *Id.* at 20. UxC also projects that term contracting activity will [REDACTED]. *Id.* at 21. Therefore, DOE concludes that only 10–20% of term sales will reflect current prices. For the next few years, most sales will be on contracts concluded several years ago when prices were higher. More contracting will take place when those contracts expire, and those contracts will reflect the relevant future term prices.

Consistent with DOE's analysis, EIA reports that in 2013, the average price paid for SWU was $142.22. EIA, Uranium Marketing Report, 7 (2014). This is well above the average market prices for 2013, approximately $110 in the spot market and $120 in the term market according to UxC.

URENCO's most recent financial statements indicate that at least a portion of its contract portfolio ''extend[s] beyond 2025.'' URENCO Limited, Interim Financial Statements for the 6 Months Ended 30 June 2014, at 6, available at *http://www.urenco.com/_/uploads/content-files/Urenco_Group_Interim_Accounts_to_30_June_2014-final-02092014.pdf*.[120] URENCO has also stated that its enrichment contracts are usually fixed base price with escalation, leaving URENCO with ''no direct exposure to uranium prices.'' URENCO Investor Update, 4 (Sept. 9, 2014), available at *http://www.urenco.com/_/uploads/results-and-presentations/URENCO_Bond_Investor_Presentation_2014.pdf*. These statements reflect all enrichment activity at URENCO, not just production at the UUSA facility. But URENCO has controlled the U.S. facility since the beginning of planning, and it is unlikely U.S. sales depart from the company's overall practices. Because UUSA began operating in 2010, its contract terms will only have begun at that time. And it is likely that the vast majority of the facility's capacity was under long-term contracts at inception, because an enrichment plant operator ordinarily does not construct a plant before having contractual commitments for virtually the entire capacity. That approach would also be consistent with what URENCO reports for its overall contracting approach.

Therefore, DOE concludes that URENCO USA has essentially zero exposure to current term prices. Transfers under the assessed case will eventually affect URENCO's realized price, because URENCO's contracts will expire and URENCO will enter new contracts at the prevailing future term prices. Therefore, DOE concludes that the effect of DOE transfers on URENCO's prices will be through the effect on longer-term, rather than near-term, prices. As noted above, the longer-term price effect forecast for transfers under the assessed case is $5.40 per SWU.

As noted above, URENCO has stated that a small amount of its capacity is devoted to underfeeding. RFI Comment of URENCO, at 3.[121] ERI notes that URENCO estimates it is using 10–15% of its capacity for underfeeding. 2015 ERI Report, 75. To the extent that URENCO sells the natural uranium hexafluoride yielded from underfeeding, DOE transfers could affect its revenues to the extent the transfers cause decreases in the prices for uranium concentrates and conversion services. Using the price effects forecast above for the uranium and conversion spot prices, transfers under the assessed case would affect the price for that amount of material by 7.1%.

2. Production at Existing Facilities

URENCO reports that the nameplate capacity for the UUSA facility is 3.7 million SWU. RFI Comment of URENCO, at 1. URENCO has also stated

[120] DOE notes that URENCO's financial statements have referred to its order book as ''extending up to and beyond 2025'' at least since 2010. *See* URENCO, Annual Report & Accounts 2010, at 3 (2010), available at *http://media.urenco.com/corp-Web site/298/annualreportandaccounts2010_1.pdf*.

[121] On May 22, 2014, URENCO submitted an application to the U.S. NRC to amend its license for the facility to allow it to use high assay tails (approximately 0.4 wt-% U–235) as feed material. *See* 79 FR 43099 (July 24, 2014); ''Redacted—Supplement to License Amendment Request for Capacity Expansion of URENCO USA Facility (LAR–12–10),'' Letter from URENCO to U.S. NRC, LES–14–00071–NRC (June 17, 2014).

that construction of additional centrifuges will continue until the facility reaches 5.7 million SWU. ''About Us, URENCO USA,'' URENCO, *http://www.urenco.com/about-us/company-structure/urenco-usa* (accessed Feb. 21, 2015).

Due to the nature of gas centrifuges, it is highly unlikely that UUSA will decrease production of SWU. As URENCO states, due to the low level of electricity required to run the centrifuges, slowing production would have almost no effect on operating expenses. Furthermore, stopping and restarting a centrifuge may damage the equipment. RFI Comment of URENCO, at 3. That said, there is a possibility that URENCO will divert capacity currently used to produce LEU to underfeeding or tails re-enrichment. Specifically, UxC notes [REDACTED]. UxC Enrichment Market Outlook—Q4 2014, 42 (2014). Given how little spot contracting activity there has been in recent years, DOE believes that this effect will be small.

3. Employment Levels in the Industry

ERI does not provide an estimate of the change in employment due to DOE transfers in the enrichment industry. No commenter references changes in employment in the enrichment industry. URENCO states that its business is essentially fixed-cost and makes no reference to changes in employment.

Although DOE notes that there have been changes in employment in the enrichment industry in recent years, mostly related to the closure of the Paducah Gaseous Diffusion Plant, DOE does not believe that its transfers will have any significant effect on employment levels in the enrichment industry.

4. Changes in Capital Improvement Plans and Development of Future Facilities

URENCO recently completed ''Phase II'' of its expansion plans, bringing the capacity of its facility to 3.7 million SWU. ''Phase II Completion,'' URENCO (Apr. 9, 2014), *http://www.urenco.com/news/detail/phase-ii-completion* (accessed Feb. 22, 2014). URENCO is continuing to move forward with ''Phase III'' expansion, which will bring plant capacity to approximately 5.7 million SWU. URENCO notes that it has slowed its plan for construction of additional capacity. RFI Comment of URENCO, at 3. URENCO expects to reach 5.7 million SWU capacity by 2023. URENCO Investor Update, 31 (Sept. 9, 2014). Although the company recently received a license amendment that would allow it to expand capacity to 10 million SWU per year, URENCO states that this move is ''to provide for future licensing flexibility should the market recover.'' URENCO notes that it cancelled construction of ''Phase IV'' in 2013. RFI Comment of URENCO, at 3.

DOE is aware of several other planned or proposed enrichment facilities in the U.S., namely, AREVA's Eagle Rock Enrichment Facility in Idaho, Centrus Energy's—formerly USEC Inc.—American Centrifuge Plant in Piketon, OH, and Global Laser Enrichment's facility in Wilmington, NC.[122] Development of each of these facilities has been put on hold or slowed until market prices improve.

The Eagle Rock Enrichment Facility would use gas centrifuge technology and would have a capacity of approximately 3.3 million SWU. ''Eagle Rock Enrichment Facility,'' AREVA, *http://us.areva.com/EN/home-203/eagle-rock-enrichment-facility.html* (accessed Feb. 21, 2015). After announcing several delays in construction, AREVA stated in May 2013 that it was no longer projecting a start date for building the facility. ''French company won't set date for Idaho nuclear facility,'' The Oregonian (May 23, 2013), *http://www.oregonlive.com/pacific-northwest-news/index.ssf/2013/05/french_company_wont_set_date_f.html* (accessed Feb. 21, 2015). At the time of this announcement, the term market price for SWU was approximately $130, according to UxC's monthly price indicator.

The proposed American Centrifuge Plant would use gas centrifuge technology and would have a capacity of approximately 3.8 million SWU. ''USEC Inc. Gas Centrifuge,'' U.S. NRC, *http://www.nrc.gov/materials/fuel-cycle-fac/usecfacility.html* (accessed Feb. 22, 2015). Active construction of new centrifuges has ceased. In a November 2013 quarterly filing with the SEC, Centrus Energy, then known as USEC, stated, ''[a]t current market prices USEC does not believe that its plans for American Centrifuge commercialization are economically viable without additional government support.'' USEC Form 10–Q, Securities and Exchange Commission, at 10 (Nov. 5, 2013) *https://www.sec.gov/Archives/edgar/data/1065059/000106505913000049/usu-2013930x10q.htm* (accessed Feb. 22, 2015). When this form was submitted to the SEC, the term market price for SWU was approximately $115, according to UxC's monthly price indicator.

Global Laser Enrichment, a venture of GE-Hitachi and Cameco, has proposed an enrichment plant that would use laser enrichment technology developed by Silex Systems, an Australian company. The proposed facility in Wilmington, NC, would have a capacity of about 6 million SWU. GLE License Application, Rev. 7, U.S. NRC, Docket 70–7016, at 1–16 (August 20, 2012), available at *http://pbadupws.nrc.gov/docs/ML1224/ML12242A227.pdf*. In July 2014, GLE announced that it would slow continued development of the facility ''in line with current and future market realities.'' ''Global Laser Enrichment,'' GE-Hitachi, *https://nuclear.gepower.com/fuel-a-plant/products/gle.html* (accessed Feb. 22, 2015). At the time of GLE's announcement, the term market price for SWU was approximately $95, according to UxC's monthly price indicator.

Based on ERI's estimate, as adjusted to account for underfeeding, eliminating all DOE–transferred material from the market—including material already transferred in the past as well as the material to be transferred under the assessed case—could cause prices to rise by no more than $7.40 in 2015 and less than $4.50 in 2016 and 2017, which could result in a term price of around $97.00 in 2015 and just under $95.00 in 2016 and 2017.

The timing of the above announcements suggests that enrichers would require a substantially higher price signal in order to move forward with adding new capacity. Specifically, the American Centrifuge project was put on hold when term prices were close to $115 and the Eagle Rock facility was put on hold when prices were close to $130. Although GLE's announcement came at a time when prices were $95, the level of near-term uncovered requirements is low—[REDACTED], UxC Enrichment Market Outlook—Q4 2014, 39 (2014)—and it is not clear that GLE would be able secure the necessary long-term contracts even at that price. Because the developers stopped the projects just discussed on the basis of prices at or above $95, DOE concludes that DOE transfers in the near term will not change the decisions whether to complete those projects. In the longer term, as prices improve, there may come a point for each of these projects at which its owner is willing to invest to complete the project. The price effect forecast for transfers under the assessed

[122] Although not the subject of this determination, DOE notes that ERI analyzed the possible future transfer to GLE of high-assay depleted uranium. 2015 ERI Report, 27–28. As this transaction would involve re-enrichment of depleted tails, it would tend to support additional demand for enrichment services.

case may delay that point, but given the forecasts and the announced decisions, DOE does not believe it would change the long-term outcome for these projects. Meanwhile, although URENCO is still moving forward with a capacity expansion from 3.7 million SWU to 5.7 million SWU, it has slowed the pace of expansion and stated that it does not expect to reach this capacity until 2023. Even though URENCO has announced expansion plans for UUSA, it presumably still intends to secure long-term contracts prior to construction. It appears that URENCO has decided to slow expansion to await higher prices that it expects will prevail in a few years—UxC's [REDACTED]. *Id.* at 114. Thus, DOE believes that a term price of $95.00–$97.00 would likely not be sufficient to support URENCO's planned price expansion.[123]

As a result, DOE believes that transfers under the assessed case will not have a significant effect on capacity expansion at UUSA or at other planned facilities.

5. Long-Term Viability and Health of the Industry

ERI's most recent Reference Nuclear Power Growth forecast projects global requirements for enrichment services to grow to approximately 59 million SWU between 2021 and 2025, approximately 31% higher than current requirements. Global requirements are expected to continue to rise to a level of 74 million SWU between 2031 and 2035, approximately 64% higher than current requirements. 2015 ERI Report, 13. ERI presents a graph comparing global requirements, demand, and supply from 2013–2035. Global supply is expected to continue to significantly exceed global demand over the long term. 2015 ERI Report, 16.

Although not focused on enrichment, the requirements forecasts noted above in Section IV.A.5 are also somewhat relevant to the enrichment industry. In general, requirements and/or uranium concentrate demand forecasts should also apply to demand for low enriched uranium. As with conversion, there may be some small differences due to strategic and discretionary inventory building. For example, China has been purchasing strategic supply well in excess of its requirements. Those purchases have come in the form of U_3O_8. 2015 ERI Report, 13. Thus, these purchases affect near-term uranium concentrate demand, but do not affect near-term demand for LEU.

In addition to demand for LEU, higher demand for uranium concentrates can affect demand for enrichment because of the relationship described above between natural uranium and enrichment as inputs for producing enriched uranium product. In the medium to long term, supply from current mines will cease to exceed demand. Meanwhile, enrichment supply will continue to exceed requirements for LEU. As prices for uranium concentrates and conversion increase relative to SWU prices, it may become more economical to re-enrich high-assay tails. In this vein, ERI suggests that enrichers will continue to redirect capacity to underfeeding and that Rosatom will continue to re-enrich tails. 2015 ERI Report, 16.[124]

In its Uranium Enrichment Outlook for the 4th quarter of 2014, UxC predicts significant increases in both requirements and demand in the long-term. UxC Enrichment Market Outlook—Q4 2014, 36, 38 (2014). Specifically, [REDACTED]. *Id.* at 38. In the longer term, UxC estimates that enrichment demand [REDACTED]. *Id.* UxC's base case supply outlook projects that supply [REDACTED]. *Id.* at 46. UxC's projected base case supply [REDACTED]. *Id.* at 50. DOE recognizes that a significant amount of the forecast increase in demand will be in China (and to a lesser extent in Russia), markets that URENCO asserts it cannot access. But enrichers in those countries do currently have access to markets elsewhere in the world, and enrichment is fungible. URENCO does not contest the notion that enrichment is essentially a global commodity with a single world price. Thus, increased demand in China and Russia will consume capacity with which URENCO would otherwise compete in markets that it can access.[125]

As discussed above in Section IV.C.1, UxC also predicts a significant increase in enrichment prices over the next ten years.

Finally, as with uranium concentrates and conversion services, DOE recognizes that the predictability of transfers from its excess uranium inventory over time is important to the long-term viability and health of the uranium enrichment industries. Again, DOE notes that the upper scenario considered by ERI would represent continued transfers at rates consistent with the May 2012 and May 2014 determinations. Compare 2015 ERI Report, 25, with 2014 ERI Report, 28.

DOE notes that enrichment market prices are at levels not seen in the past decade. There is also tremendous uncertainty in the market regarding future production. Centrus Energy Corp. (formerly USEC, Inc.) emerged from bankruptcy in the past year and has been forced to rethink its business model since the closure of the Paducah Gaseous Diffusion Plant. A significant source of business for Centrus and URENCO in recent years has been from the Asian markets, specifically Japan, Taiwan, and South Korea. Demand in these markets has been directly affected by the Fukushima Daiichi accident. In addition, the enrichment market faces uncertainty related to Areva's finances and the potential for GLE to build and operate a new facility utilizing the Silex technology. DOE is cognizant of these uncertainties facing the market.

However, as described above, enrichment capacity is expected to shift over time toward a trajectory that more closely tracks demand. The moves in recent years by several enrichers to curtail or postpone planned capacity increases contributes to this. As a result, prices are expected to recover over the next ten years. DOE does not believe that the price effect attributable to DOE transfers is large enough to cause a significant change to production and development plans at existing or planned facilities. At worst, as with the uranium mining industry, the effect of DOE transfers would be to shift major capital investments later in time. DOE does not believe that this difference is significant enough to appreciably affect the long-term viability and health of the domestic uranium enrichment industry.

6. Russian HEU Agreement and Suspension Agreement

Section 3112(d) of the USEC Privatization Act requires DOE to ''take into account'' the sales of uranium

[123] URENCO similarly notes that uncovered requirements are low. URENCO further notes that DOE transfers are equivalent to about 72% of unfilled global demand in 2015. RFI Comment of URENCO, at 4. As noted in the NIPC, DOE believes that figures for unfilled enrichment demand or uncovered enrichment requirements likely already reflect DOE uranium transfers at recent rates. Even if this were not true, the prediction above for the price effect of DOE transfers does not depend on an estimate of uncovered requirements. Thus, changing this input would not alter DOE's forecast. URENCO may also be suggesting that the lack of uncovered requirements means that DOE is directly displacing its own sales. However, as described above, even if DOE transfers were removed from the market, it does not appear that prices would rise enough to justify UUSA's increasing capacity substantially.

[124] Again, DOE notes that although it is not included in ERI's chart of enrichment supply, GLE's proposed Paducah Laser Enrichment Facility would represent additional enrichment supply that is not intended to be devoted to producing LEU. Compare 2015 ERI Report, 16, with 2015 ERI Report, 27–28.

[125] DOE also notes that the Russian Suspension Agreement places limits on EUP imported into the United States from Russia. Thus, URENCO is somewhat protected from the effects of competition with Russian enrichers for domestic demand.

under the Russian HEU Agreement and the Suspension Agreement. As discussed above, DOE believes this assessment should consider any transfers under these two agreements that are ongoing at the time of DOE's transfers.

Under the Russian HEU Agreement, Russian HEU was down-blended to LEU and then delivered to USEC Inc. for sale to end users in the United States. DOE notes that the Russian HEU Agreement concluded in December 2013. Thus, there are no ongoing transfers under this agreement.

The current iteration of the Suspension Agreement, described above in Section I.D.3.b, sets an annual export limit on natural uranium from Russia. 73 FR 7705 (Feb. 11, 2008). That agreement provides for the resumption of sales of natural uranium and SWU beginning in 2011. While the HEU Agreement remained active (*i.e.* 2011–2013), the annual export limits were relatively small—equivalent to between 100,000 and 250,000 SWU. After the end of the Russian HEU Agreement, restrictions range between an amount equivalent to 2,750,000 and 3,110,000 SWU per year between 2014 and 2020. 73 FR 7705, at 7706 (Feb. 11, 2008). Material having a SWU component imported from Russia in accordance with the Suspension Agreement is not derived from down-blended HEU; thus, this material is part of worldwide primary enrichment supply as analyzed by ERI in the 2015 ERI Report. This material is also presumably accounted for in the various projections and models developed by UxC. Thus, DOE's analysis takes those sales that have an enrichment component under the Suspension Agreement into account as part of overall supply available in the market.

7. Enrichment Industry Conclusion

After considering the six factors as discussed above, DOE concludes that transfers under the assessed case will not have an adverse material impact on the domestic uranium enrichment industry. As explained above, DOE transfers under the assessed case will continue to exert some downward pressure on the market price for enrichment services. DOE believes that $5.25 per SWU in the near-term and $5.40 per SWU over the longer term is a reasonable estimate of the price effect attributable to DOE transfers; this is somewhat smaller than the effect transfers in the past few years have had. Sales from UUSA, the sole operating enrichment facility in the United States, are almost exclusively under term contracts with no exposure to the spot price. Thus, the effect of DOE transfers on realized price for enrichment from UUSA will come through the effect on new term contracts that URENCO will enter into in the longer term, *i.e.* $5.40 per SWU. DOE transfers may also affect the price realized for natural uranium hexafluoride from underfeeding at UUSA by about 7%. Because DOE believes that less than 15% of UUSA's capacity is devoted to underfeeding, this effect is expected to be small. Due to technical constraints, DOE concludes that the price effect attributable to DOE transfers under the assessed case will not cause URENCO to decrease capacity or change employment levels at UUSA.

DOE believes that decisions to expand capacity at UUSA or at other planned enrichment facilities require prices significantly higher than current prices. This would be true with or without DOE transfers. Thus, DOE concludes that transfers under the assessed case will not have a significant effect on near-term decisions to build future enrichment capacity in the United States. DOE expects that SWU prices will increase in the medium- to long-term enough to support these expansion plans. DOE transfers would, at worst, have the effect of slightly delaying the development of such future capacity without preventing these new facilities from coming online. As such, DOE concludes that transfers under the assessed case would not significantly affect the long-term viability or financial health of the domestic uranium enrichment industry. DOE does not believe that any of these effects has the substantial importance that would make it an ''adverse material impact'' within the meaning of section 3112(d).

V. Other Comments

DOE received a number of comments in response to the NIPC and RFI that warrant additional discussion. Many comments included suggestions for how DOE might mitigate any potential adverse impacts.

Several commenters asserted that for a given amount of transferred uranium, introducing the material into the spot market is particularly harmful to industry. These commenters contend that DOE should analyze its transfers on the assumption that the material is primarily appearing on the spot market. They also urge DOE to take steps to ensure that the uranium it transfers is sold through term contracts, rather than through spot contracts or through future-delivery contracts that commenters say are little different from future spot contracts. Some of these commenters, representing members of the domestic mining industry, suggest that DOE could achieve this goal by distributing its material through uranium concentrate producers. These producers, the commenters say, have incentives to place DOE-sourced uranium into long-term deliveries, in order to mitigate the effect on spot prices. To the extent such an arrangement led to higher spot prices, DOE would also receive greater value for the uranium.

With respect to the impacts caused by DOE transfers, the foregoing analysis has, in almost all respects, assumed the material contributes to the spot markets over time.[126] DOE therefore believes its analysis has comported with commenters' suggestion. Assuming the commenters are correct that spot sales of DOE-sourced uranium are the most harmful way for the material to enter the markets, DOE has assessed the consequences.

DOE recognizes that if some or all of its transfers entered the markets through term contracts, the effects on spot prices could be smaller.[127] However, for DOE itself to make transfers on the equivalent of traditional term contracts would not serve the purposes for which, in the main, DOE transfers uranium. In DOE's understanding, a buyer on a term contract has a right to receive material at various future delivery dates; and it ordinarily pays for the material at or near the time of delivery, at a price determined by the contract. By contrast, DOE transfers uranium in exchange for services provided substantially contemporaneously with the transactions, not years in the future.

At least one commenter says that some utility buyers have the financial capacity to buy uranium and hold it for a few years before using it. According to the commenter, the price curve for uranium, coupled with the financial environment in which interest rates have remained very low, makes such transactions advantageous for utilities. DOE notes, however, that holding the

[126] As noted above, one exception to this approach is ERI's econometric model for the spot price of uranium concentrates, for which the difference between term sales and spot sales of DOE-sourced uranium could influence the model's medium- and long-term forecasts. Because DOE considers those forecasts fairly uncertain anyway, the possibility that less DOE-sourced uranium is delivered on term contracts than ERI assumed would not alter DOE's conclusions.

[127] Assessing whether the effects would actually be smaller, and by how much, would require additional analysis. For example, if a term sale of DOE-sourced uranium displaced a corresponding amount of supply onto the spot market, the overall effect could be the same as if the DOE-sourced uranium were sold directly on the spot market. The likelihood of such a direct displacement differs among the uranium concentrates, conversion, and enrichment markets.

material for a few years would not, apparently, serve the purpose of commenters who seek to remove DOE-sourced material from the spot markets. These commenters stress that what they consider the true term market involves deliveries five to ten years in the future. No commenter identified a person or group of persons that would have the financial wherewithal to pay the spot price for DOE-sourced uranium in the present and then retain the uranium for delivery that far in the future.

Commenters from the mining industry did indicate that they would be interested in managing the distribution of DOE-sourced uranium. However, DOE notes that the commenters appear to contemplate that DOE would receive in such an arrangement substantially less than the prevailing spot market price for the uranium. If, on the other hand, the commenters expect to pay prevailing spot market prices, DOE believes they could in principle already undertake to manage how the material enters the markets. DOE transfers uranium to commercial businesses; and one of them, DOE believes, sells its uranium to Traxys, a uranium trading firm. A person that wanted to buy uranium from DOE to transfer it from the spot market to the term market could buy the equivalent amount of material from Traxys instead.

For these reasons, while DOE is willing to explore whether it would be feasible for some persons, such as uranium concentrate producers, to manage the appearance of DOE-sourced uranium on the markets, DOE does not consider it appropriate to incorporate this suggestion in today's determination.

Commenters also suggested a variety of other actions that could help to mitigate the impact of DOE transfers. Several suggested that DOE consider a matched sales arrangement similar to the arrangement used during an earlier iteration of the Suspension Agreement with Russia. Under that program, Russian-origin natural uranium (U_3O_8 or UF_6) or SWU could only be imported into the U.S. if it was ''matched'' to an equal portion of newly-produced U.S. origin natural uranium or SWU and the two quantities were sold together as a unit. *See generally* 59 FR 15,373 (Apr. 1, 1994). Commenters suggest that an arrangement of this type for DOE-sourced uranium would incentivize new production capacity that is not already committed to long-term contracts. DOE acknowledges that a matching program could benefit domestic producers, but it is concerned that it would not serve the purposes for which DOE transfers uranium. In general, domestic producers already participate in domestic and global spot markets for uranium. A new sale that would not have occurred absent the matching program will tend to be from production that would not have been economic at current prices. The effect of a matching program would be to secure a viable, somewhat above-market price for the new sale. Because buyers will presumably be unwilling to pay more than the relevant market prices overall, the DOE-sourced uranium would have to be transferred at a lower price to compensate. The net effect would be for DOE to receive less value for its uranium in exchange for an additional monetary benefit to producers. For these reasons, DOE declines to incorporate a matched sales approach into today's determination.

One commenter suggested several alternatives to DOE's exchanging LEU for down-blending services. First, the commenter suggested that DOE down-blend only to an assay of 19.75 wt-% U–235, an assay that commercial enrichers do not provide and therefore will not compete with commercial supply. However, because there is very little demand for LEU at this assay—which is predominantly used in research reactors—the resulting LEU would have little value to a contractor receiving it in exchange for services. Granted, the contractor could down-blend the LEU further to assays of 5 wt-% or below; but that outcome would affect markets the same as if DOE itself transferred the low-assay LEU. Further, DOE allocates the portion of the down-blended LEU that is not transferred to the down-blending contractor to various programmatic needs, many of which require LEU with an assay of 5 wt-% or below. The commenter also suggests that DOE devote the LEU resulting from down-blending to either the U.S. nuclear fuel bank, the American Assured Fuel Supply, or to the IAEA's nuclear fuel bank. Both proposals amount to a request that DOE cease exchanging LEU for down-blending services altogether. The second proposal suggests that the difference in funding could be made up by decreasing U.S. financial contributions to the IAEA by an amount equivalent to the value of the LEU. The Agency currently plans to purchase LEU from the market to stock its fuel bank. If the United States provided LEU, the IAEA would need to purchase less LEU from the market. Thus, it appears that this type of transaction would not decrease the impacts on the domestic enrichment industry because it would displace purchases of LEU on the open market that the IAEA would have otherwise made. In any case, DOE believes that it can meet its purpose of exchanging 4.95 wt-% LEU for down-blending services without causing an adverse material impact on the domestic uranium industries; thus, DOE declines to incorporate these alternatives into today's determination.

One commenter suggested that DOE should consider as a mitigating strategy implementing regulations that limit the amount of secondary supply obtained from underfeeding that enrichers can sell in the United States. Doing so would mean protecting producers from competition with underfeeding by enrichers, at enrichers' expense. DOE is not inclined to engage in such capacity controls.

With respect to the domestic conversion industry, one commenter suggested stopping transfers of conversion services would have a positive effect. DOE does not transfer conversion services; it transfers natural uranium hexafluoride. This displaces primary conversion because in order to obtain natural uranium hexafluoride from primary production, one would need to buy uranium concentrates and then pay for that material to be converted into uranium hexafluoride. The commenter is presumably suggesting that DOE should accept in exchange for its uranium an amount of services equivalent to the value of the uranium concentrates and ''credits'' for the amount of conversion services necessary to produce the material from primary production. These ''credits'' would be in the form of a tradeable contract for conversion services from a primary supplier. This process would mean that DOE would receive less services in exchange for its uranium while making the individual transfers substantially more complicated. DOE further notes that this would decrease the impacts on the domestic conversion industry, but it would have no effect on the impacts to the domestic uranium mining or enrichment industries. For these reasons, DOE declines to engage in this type of transaction.

One commenter also suggested that DOE could establish price bands below which DOE would not transfer uranium. The commenter presented this proposal specifically for conversion services. Thus, this would require DOE to accept conversion ''credits'' as described in the preceding paragraph if the conversion price fell below a given threshold. However, DOE recognizes that this approach could in principle apply to any uranium transfers. As DOE has concluded that its transfers will not have an adverse material impact on the domestic uranium industries in market conditions that are expected to occur,

DOE declines to establish price thresholds below which DOE will transfer less uranium. However, DOE expects to reassess its transfers at least every two years, consistent with the statutory limit on the validity of section 3112(d)(2) determinations. Such reassessments are, among other things, an opportunity to ensure that DOE evaluates its transfers in light of changing market conditions.

In addition to comments regarding potential ways to mitigate any impacts caused by DOE transfers, DOE received a number of comments that are related to DOE's current plans, but do not directly implicate how DOE conducts its analysis of whether DOE transfers will cause adverse material impacts.

One commenter suggested that DOE should prepare two separate Secretarial Determinations—one for Portsmouth cleanup, and one for down-blending services. DOE agrees that it could conceivably prepare separate determinations for these two programs. However, DOE believes it is more informative to analyze these transfers together, to assess their cumulative impacts on the domestic uranium industries. Thus, DOE declines to adopt separate determinations for these programs at this time. This commenter also suggests that DOE could potentially conduct transfers for down-blending under section 3112(e)(2) of the USEC Privatization Act, which allows certain transfers for national security purposes. DOE recognizes that certain programs may potentially fall under more than one subsection of the Act. DOE believes it is unnecessary to determine whether these transfers could be conducted under section 3112(e)(2) because DOE has concluded that these transfers will not have an adverse material impact on the domestic uranium industries.

Several commenters suggested that DOE is not getting fair market value for its uranium—as section 3112(d)(2)(C) of the USEC Privatization Act requires—because DOE values the material at the spot price rather than the term price. This assessment does not analyze whether DOE will receive fair market value for its transfers. DOE evaluates whether it receives fair market value prior to each transfer through a separate process. With respect to this analysis, DOE has assumed that in its uranium transfers it will receive roughly the prevailing spot price for its material. That assumption is reasonable because it is consistent with DOE's past experience and with the contracts under which DOE transfers uranium.

DOE received a number of comments requesting that it publish a draft Secretarial Determination for notice and comment. DOE notes that notice and comment is not required for determinations pursuant to section 3112(d)(2). However, DOE has solicited public comment on two occasions in preparation for this determination, through a December 2014 Request for Information and a March 2015 Notice of Issues for Public Comment. DOE received substantial input, described above, in response to those two notices, and it has carefully considered these comments.[128]

VI. Conclusion

For the reasons discussed above, DOE concludes that transfers under the assessed case will not have an adverse material impact on the domestic uranium mining, conversion, or enrichment industries, taking into account the Russian HEU Agreement and Suspension Agreement.

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[128] One commenter suggested that DOE subject each Secretarial Determination to an analysis under the National Environmental Policy Act. DOE notes that the actual uranium transfers—as opposed to the Secretarial Determination—are already covered under other NEPA processes. Thus, it is unnecessary to conduct further NEPA analysis for today's determination.