SECRETARIAL DETERMINATION
FOR THE SALE OR TRANSFER OF URANIUM

Since May 1, 2015, the Department of Energy ("Department," "DOE") has transferred natural uranium and low-enriched uranium in specified amounts and transactions, subject to a determination made on that date pursuant to § 3112(d)(2) of the USEC Privatization Act, 42 U.S.C. § 2297h-10(d).

After reviewing the 2017 "Analysis of Potential Impacts of Uranium Transfers on the Domestic Uranium Mining, Conversion, and Enrichment Industries," prepared by DOE, considering responses to the Department's solicitations for public input, noting the Department's goals regarding the projects being partly supported by uranium transactions, and recognizing the Department's interest in maintaining healthy domestic nuclear industries, I have concluded that the lower rates of uranium transfers described herein are appropriate. I have therefore determined to permit transfers only at the lower rates described below.

Accordingly, I determine that the following uranium transfers will not have an adverse material impact on the domestic mining, conversion, or enrichment industry:

> For the remainder of calendar year 2017, up to an additional 800 MTU contained in natural uranium hexafluoride, transferred to contractors for cleanup services at the Portsmouth Gaseous Diffusion Plant, in transfers of up to 200 MTU in the second quarter and up to 300 MTU per quarter in the third and fourth quarters.
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> For calendar year 2018 and thereafter, up to 1,200 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 300 MTU per quarter.

I base my conclusions on the Department's 2017 "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.

Richard Perry
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26 Apr 2017
Date

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

April 26, 2017

EXECUTIVE SUMMARY:

The Department of Energy ("Department" or "DOE") currently is transferring excess uranium at a rate of 1,600 metric tons (MTU) per year in exchange for cleanup services at the Portsmouth Gaseous Diffusion Plant. A prerequisite to continuation of these transfers after May 1, 2017, pursuant to the USEC Privatization Act, is a determination by the Secretary of Energy that the planned transfers will not have an adverse material impact on the domestic mining, conversion, or enrichment industry. In support of a 2017 determination the analysis below assesses the potential impact of planned transfers going forward.

This analysis considers two different scenarios for planned transfers of natural uranium (NU) for cleanup services at Portsmouth—transfers of up to the equivalent of 1,600 MTU of NU for calendar years 2017 and thereafter ("Base Scenario"), and transfers at a rate of up to 1,200 MTU per year beginning in May 2017 until the current stockpile of natural uranium is exhausted. The Department concludes that transfers at either rate will not have an adverse material impact on the domestic mining, conversion, or enrichment industry. The Department further notes that transfers at the lower rate of 1,200 MTU per year will have lesser impacts than the Base Scenario.

In sum, for purposes of the Secretarial Determination, transfers are deemed to have an "adverse material impact" if a reasonable forecast predicts that an industry will experience "material" harm that is reasonably attributable to the transfers. This analysis compares the expected state of each industry in light of the planned transfers to the expected state of each industry without the planned transfers and examines to what degree the effects of DOE's future planned transfers would impact the industries. In this case, 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.

This 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 various inputs, including a report prepared for the Department by consultant Energy Resources International, Inc., market data and forecasts from several sources, reports by other market consultants, and submissions in response to the Department's requests for public comment.

The uranium mining industry serves the market for uranium concentrates. DOE's transfers under the Base Scenario constitute 4% of global demand and 13% of U.S. demand for uranium concentrates in the near-term, 2017-2019. The Department forecasts, on the basis of results from multiple economic models that transfers will tend to suppress prices in the next decade by approximately $1.40 per pound, and in the near-term (2017-2019) by approximately $1.60 per pound. These impacts are about 6 or 7% of current spot market price. Transfers at the lower rate of 1,200 MTU per year are expected to have a smaller effect. The level of price suppression under either scenario is within the range of recent market price fluctuations. The impact on production and employment under either scenario in the industry will also be limited. In the long-term, the Department concludes that the effect of its transfers under either scenario would delay decisions to expand or increase production capacity but would not change the eventual outcomes in this regard.

The uranium conversion industry processes uranium concentrates into uranium hexafluoride suitable for enrichment. DOE's transfers, under the Base Scenario, constitute 4% of global demand

and 14% of U.S. demand for conversion services in 2017-2019. Most conversion is sold on long-term contracts, and the sole domestic converter makes essentially all of its sales that way. The Department concludes that the term price will be relatively stable despite DOE's transfers. Although DOE transfers are projected to cause a suppression of the global spot price by about $0.30 per kgU in the next decade, about 5% of current spot prices, the domestic industry has little exposure to the spot price. As with uranium concentrates, transfers at the lower rate of 1,200 MTU per year are expected to have lesser impacts. As a result the Department concludes that its transfers under either scenario will have, at most, limited impact on employment and plans for capital improvement and expansion.

The enrichment industry provides enriched uranium, which has higher levels of U^{235} than natural uranium. For context, this analysis also discusses the effects of DOE's planned transfers of LEU, which are not part of the action being approved by the Secretarial Determination. This analysis concludes that the planned transfers of natural uranium will not have a direct effect on the enrichment industry because transfers of natural uranium only directly impact the uranium mining and conversion industries. This analysis does take into account, however, indirect effects, including the effects on operational decisions in the enrichment industry potentially caused by a larger supply of natural uranium. The Department concludes that production at existing enrichment facilities and employment in the industry are affected by the current imbalance in supply and demand, with only a limited portion of that effect being reasonably attributable to DOE transfers.

The Department has made its projections in recognition of current conditions in the market, and acknowledges that these conditions have been challenging for all three industries. Answering the analytical question posed by section 3112(d)(2) of the USEC Privatization Act requires a forecast of only the additional harm industry would suffer that can reasonably be attributed to its future planned transfers of uranium. The Department concludes that the potential effects to the domestic uranium mining, conversion, and enrichment industries from future transfers under either the Base Scenario or at the lower rate of 1,200 MTU per year will not constitute adverse material impacts.

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I. INTRODUCTION

A. Review of procedural history

The Secretary has periodically determined whether certain transfers of natural and low-enriched uranium will have an adverse material impact on the domestic uranium industries. DOE issued the most recent Secretarial Determination under Section 3112(d) covering transfers for cleanup at the Portsmouth Gaseous Diffusion Plant and down-blending of highly-enriched uranium (HEU) to low-enriched (LEU) on May 1, 2015.[1] The 2015 Secretarial Determination and Analysis recounted in detail the history of prior DOE uranium transfers and the 2008 and 2013 DOE excess uranium inventory management plans. Introductory information provided in the 2015 Secretarial Determination and Analysis, and other information as noted below, is incorporated by reference and repeated here in part or updated as appropriate.

In preparation for this Secretarial Determination, DOE sought information from the public through a Request for Information (RFI) published in the Federal Register on July 19, 2016 (81 FR 46917). DOE specifically requested comment on the uranium markets and the potential effects of planned DOE uranium transfers on the domestic uranium industries. In response to the RFI, DOE received comments from a diverse group of parties representing interests across the nuclear industry, including members of the uranium mining, conversion, and enrichment industries, 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 2017 through 2026 ("2017 ERI Report").

On March 9, 2017, DOE published a Notice of Issues for Public Comment (NIPC) in the Federal Register (82 FR 13106) ("NIPC"). That notice announced the public availability of comments received in response to the July 2016 Request for Information, the 2017 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] Citations to comments received in response to the RFI or NIPC are denoted by the commenter and page number of comments submitted; e.g., "NIPC Comment of Uranium Producer, at 3," is found on page 3 of "Uranium Producer's" comments submitted in response to the NIPC.

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[1] See Excess Uranium Management: Secretarial Determination of No Adverse Impact on the Domestic Uranium Mining, Conversion, and Enrichment Industries, 80 Fed. Reg. 26366 (May 7, 2015) (hereinafter 2015 Secretarial Determination), and the analysis incorporated by reference in the 2015 Secretarial Determination (hereinafter 2015 Secretarial Determination and Analysis).

[2] The 2017 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.

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 authorizes DOE to transfer special nuclear material and source material. LEU and NU are types of special nuclear material and source material, respectively. The USEC Privatization Act (Public Law 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)(B) of the USEC Privatization Act (42 U.S.C. 2297h-10(d)(2)(B)), the Secretary must determine that certain transfers of natural or low-enriched uranium "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 these transfers under its AEA authority (hereinafter referred to as "Secretarial Determination" or "Determination"). Section 306(a) of Division D, Title III of the Consolidated and Further Continuing Appropriations Act, 2015 (Public Law 113-235), limits the validity of any determination by the Secretary under Section 3112(d)(2)(B) of the USEC Privatization Act to no more than two calendar years subsequent to the determination.

Section 3112(e) of the USEC Privatization Act (42 U.S.C. 2297h-10(e)), however, provides for certain transfers of uranium without the limitations of Subsection 3112(d)(2). For example, under Subsection 3112(e)(2), the Secretary may transfer or sell enriched uranium to any person for national security purposes. Nevertheless, this analysis considers the impact of transfers made pursuant to Section 3112(e) along with other DOE transfers in any determination made to assess the adverse impacts of the Department's transfers under Section 3112(d).

C. Recent DOE transfers and excess uranium inventory

DOE has detailed its transfers up to 2014 in the 2015 Secretarial Determination and Analysis.[3] Pursuant to the 2015 Secretarial Determination, DOE transferred 2,500 MTU NU equivalent in calendar year 2015, broken down as follows: 500 MTU of NU equivalent in the form of LEU transferred for down-blending services and 2,000 MTU of NU equivalent for cleanup services at the Portsmouth Gaseous Diffusion Plant. From the beginning of calendar year 2016 until now, DOE has transferred at a rate of 2,100 MTU per calendar year NU equivalent, broken down as follows: up to 500 MTU per year of NU equivalent in the form of LEU transferred for down-blending services, with the balance transferred for cleanup services at the Portsmouth Gaseous Diffusion Plant. Transfers for cleanup services at the Portsmouth Gaseous Diffusion Plant from January through April of 2017 have been about 530 MTU.

Table 1 provides an overview of DOE's inventory of excess uranium as of December 31, 2016.

[3] 2015 Secretarial Determination, 80 Fed. Reg. at 26367, 26366, 26369.

1. *Current excess uranium inventory*

Inventory	Enrichment Level	MTU	NU Equivalent Million lbs. U_3O_8	NU Equivalent MTU
Unallocated Uranium Derived from U.S. HEU Inventory	HEU/LEU	4.5	2.0	774†
Allocated Uranium Derived from U.S. HEU Inventory	HEU/LEU	8.6	4.2	1607†
U.S.-Origin NU as UF_6	NU	3,194	8.3	3,194
Russian-Origin NU as UF_6	NU	2,091	5.4	2,091
Off-spec UF_6 as LEU	LEU	1,218	5.2	2,015
Off-spec Non-UF_6	NU/LEU	221	1.6	600
Depleted Uranium Hexafluoride (DUF_6)*	DU	300,000	208-260	80,000-100,000

† The NU equivalent shown for HEU is the equivalent NU within the LEU derived from this HEU, most of which will be retained by DOE in the timeframe under consideration herein. This table includes LEU down-blended from HEU and HEU that is to be down-blended or that is in the process of being down-blended.
* DUF_6 quantity is based on uranium inventories with assays greater than 0.25% U^{235} but less than 0.711% U^{235}. The amount of NU equivalent is subject to many variables, and a large range has been shown to reflect this uncertainty. DOE has additional DUF_6 inventory that is equal to or less than 0.25% U^{235} that is not reported in this Table.

Table 1. Overview of DOE Excess Uranium Inventories as of December 31, 2016

D. Transfers considered in this determination

This section provides an overview of the various uranium transactions considered in this analysis. The first category are transfers 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 are not subject to section 3112(d), but which may be relevant to DOE's analysis of the possible impacts of transfers in the first category. The third category includes transfers that may be subject to section 3112(d) but do not impact the commercial domestic uranium markets, and are included for completeness without further consideration. The fourth category are transfers made under the Russian HEU Agreement and Suspension Agreement, which do not directly involve DOE, but are considered as required under section 3112(d).

1. *Planned transfers covered by this Secretarial Determination under section 3112(d)*

Today's determination concludes that transfers of natural uranium for cleanup services at the Portsmouth Gaseous Diffusion Plant at the current rate of 1,600 MTU per year or at the lower rate of 1,200 MTU per year will not cause an adverse material impact on the domestic uranium industries.

Through its Office of Environmental Management (EM), DOE contracts with Fluor- BWXT 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.

This analysis considers planned transfers of natural uranium hexafluoride for cleanup services at the Portsmouth Gaseous Diffusion Plant under two scenarios. The first scenario consists of continued transfers at the current rate of 1,600 MTU per year until the Department's natural uranium supplies are exhausted in 2020. The second scenario consists of transfers for the remainder of calendar year 2017 and thereafter, at a rate of 1,200 MTU per year, until the Department's uranium supplies are exhausted in 2021. This scenario accounts for transfers that have already occurred in 2017 at the higher rate of 1,600 per year and initiates the lower rate of 1,200 MTU per year beginning May 2017.

2. *Uranium transfers considered but not covered by this Secretarial Determination*

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), this analysis considers the potential impacts on domestic industries and the expected impacts of those yet to be carried out, to provide a complete picture of the Department's uranium transfers[4].

i. NNSA Transfers for HEU Down-blending

As discussed in the NIPC, NNSA transfers of LEU for HEU down-blending services were determined to serve a national security purpose in supporting the Department's nonproliferation goals and are thus covered by Section 3112(e)(2). Pursuant to Section 3112(e), these transfers for down-blending purposes no longer require a Secretarial Determination under Section 3112(d). However, this analysis still considers proposed NNSA LEU transfers of 500 MTU per year from 2017 to 2019 for the purposes of assessing the impact of DOE's natural uranium transfers for EM cleanup services at the Portsmouth Gaseous Diffusion Plant.

ii. Depleted uranium hexafluoride to Energy Northwest

This analysis considers uranium transfers made in the past that continue to displace commercial supply. In 2012 and 2013, DOE transferred 9,075 MTU of high assay depleted uranium hexafluoride (DUF_6) tails 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

[4] The 2015 Secretarial Determination also considered uranium transfers under the TVA BLEU program, a program dating from 2005 where TVA has been blending off-spec HEU from the NNSA for use in its reactors. Since 2015, NNSA has not finalized plans for additional down-blending of off-spec HEU, and therefore there are no further transfers of material associated with the TVA BLEU program in the 2017 to 2026 time period. 2017 ERI Report, 22, 23.

most of the resulting LEU to TVA, for use in its reactors between 2015 and 2022. Energy Northwest retained the remaining LEU for us in its own reactors. DOE accepted title to 8,582 MTU of secondary tails resulting from the enrichment of the high-assay tails.

iii. Depleted uranium hexafluoride to Global Laser Enrichment and off-spec inventory transfers

This analysis also considers certain planned and future DOE transfers which are outside of the two-year window of the Secretarial Determination. In July 2013, DOE issued a Request for Offers (RFO) for the sale of depleted and off-specification uranium hexafluoride inventories. These inventories include large amounts of high-assay and low-assay DUF_6, approximately 538 thousand MTU of DUF_6 in over 65,000 cylinders located, and smaller amounts of "off-spec" (meaning material that does not meet American Society for Testing and Materials specifications) uranium hexafluoride, approximately 1,106 MTU contained in 239 cylinders, located at DOE's Portsmouth and Paducah sites.

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

Following the July 2013 RFO, DOE entered into negotiations with GE-Hitachi Global Laser Enrichment, LLC (GLE) for the sale of the DUF_6, which resulted in an agreement in November 2016. Subject to the terms and conditions of the agreement, in 2024, DOE expects to begin annual transfers of depleted uranium to GLE, in an amount equal to 2,000 MTU of NU equivalent. GLE would enrich the depleted uranium to NU at a new laser enrichment facility it intends to build near the Paducah site.

Also in connection with the July 2013 RFO, DOE announced in November 2013 that it would enter into negotiations with AREVA for the sale of off-spec uranium hexafluoride in the form of LEU.

To date, the proposed sales of off-specification LEU and off-specification non-UF_6 have not been concluded. If concluded, DOE expects that off-spec LEU in an amount equal to approximately 456 MTU as natural uranium equivalent would enter the market in 2020, and off-spec non-UF_6 in an amount equal to approximately two MTU as NU equivalent would enter the market in 2021 or 2022.

iv. Uranium transfers for research applications and medical isotope production

DOE also transfers LEU enriched to assays between 5 and 20 wt-% U^{235} (hereinafter high-assay LEU) 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. DOE issued two Secretarial Determinations under section 3112(d) to cover transfers of high-assay LEU in connection with the development and demonstration of, and the establishment of production capabilities for, respectively, the medical isotope molybdenum-99.[5]

In general, these transfers of high-assay LEU 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 high-assay LEU, 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 and medical isotope production 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 above, 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").

The 2015 Secretarial Determination and Analysis detailed the history of transfers which have taken place under the Russian HEU Agreement, the last of which took place in 2013, and those which may occur in the future under the Suspension Agreement. The specific volumes of uranium, conversion, and enrichment allowed into the United States from Russia under the Suspension Agreement are discussed below. Material imported under the Suspension Agreement would not involve DOE transfers but would be accounted for in the various projections and models of the uranium markets that are considered in this analysis.

Two developments with respect to the Suspension Agreement since the 2015 Secretarial Determination bear mention. First, the Suspension Agreement requires the Department of Commerce to adjust the export limits in 2016 and 2019 to take account of changes in projected reactor demand for uranium, and Commerce proposed such adjustments in September 2016 and requested comment from interested parties. Letter from Sally C. Gannon, International Trade Administration, Department of Commerce, Sept. 9, 2016. The proposed adjusted export limits are, on average, 6.6 percent above current limits over the remaining years of the agreement. Commerce has not yet issued final adjusted export limits.

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[5] See Excess Uranium Management: Secretarial Determination of No Adverse Impact on the Domestic Uranium Mining, Conversion, and Enrichment Industries, 80 Fed. Reg. 65727 (October 27, 2015), and Excess Uranium Management: Secretarial Determination of No Adverse Impact on the Domestic Uranium Mining, Conversion, and Enrichment Industries, 81 FR 1409 (January 12, 2016).

Second, the Suspension Agreement requires Commerce to conduct sunset reviews in 2011 and 2016. In February 2017, the Department of Commerce initiated the fourth sunset review. 82 FR 9193 (Feb. 3, 2017). Commerce expects to issue final results of this review within 120 days of publication of the initiation. In the previous five-year review, Commerce determined that termination of the Suspension Agreement and underlying anti-dumping investigation would likely lead to a continuation or recurrence of dumping and therefore declined to terminate the Agreement. 76 FR 68404, at 68407 (Nov. 4, 2011). DOE's analysis assumes that the Suspension Agreement will remain in effect through 2020.

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. The 2015 Secretarial Determination and Analysis discussed the primary players and drivers of the U.S. uranium industries. As in section I of this analysis, the information in this section incorporates by reference and repeats in part the information provided in the 2015 Secretarial Determination and Analysis, updated as appropriate.

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.

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. Conversion is a chemical process that 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}.[6] 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.

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."[7] NU consists of approximately 0.711% U^{235}, 99.283% U^{238}, and trace amounts of U^{234}.

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 LEU if the assay is less than 20% but above 0.711%, and as 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. 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, this UF_6 or "feed" is introduced into the enrichment centrifuges.

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

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

The centrifuges exploit the slight mass difference between U^{235} and U^{238} atoms and separate the isotopes into varying levels of enrichment. Two streams of material are produced: product and tails. The product is the enriched UF_6 or LEU output (also referred to as Enriched Uranium Product or EUP), which is pumped into a 2.5 ton cylinder and shipped to a fabrication facility. To achieve a concentration increase from 0.711% to 5% in a centrifuge, material passes sequentially through many stages of centrifugation.

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 sometimes referred to as "depleted." 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 wt-% to 0.4 wt-%. Tails are pumped into large (typically 10 or 14 ton) cylinders and then stored on-site at the enrichment facility for eventual disposal or other use. Some depleted uranium may be of value to the market depending on the assay level, cost to re-enrich and other market conditions.

Enrichment services are sold in "separative work units" (SWU). One SWU is the amount of effort it takes to enrich uranium of a given isotopic concentration to a specified enriched level with a specified tails assay for the depleted uranium.

4. *Fabrication*

The final step in the process is fabrication. Almost all commercial 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" and may include government inventories of uranium, commercial inventories (some strategic and some resulting from shutdown nuclear power plants), uranium produced by re-enriching depleted tails, and uranium resulting from enricher underfeeding. An additional source of secondary supply is from recycled uranium and plutonium either from reprocessing of commercial spent fuel or from weapons-grade plutonium disposition. The product of these processes enters the fuel cycle and is fabricated into mixed oxide (MOX) fuel.

Most secondary supply comes from utilization of excess enrichment capacity by underfeeding or re-enriching tails. 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. Doing so would risk damaging the machine and destroying the substantial capital investment. 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 uranium 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 feed material 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 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 customer's desired amount of enriched product plus depleted tails as well as the natural uranium that was delivered to the enricher but not fed into the enrichment process. The enricher can then sell this excess 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. Over time, depleted tails may accumulate and an enricher may choose to 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.

6. *Note on 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 390 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, but interrelated*

Uranium concentrates, conversion services, and enrichment services are traded in separate markets, with the demand for each tied to both technical specifications and utility procurement strategies. 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. 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*

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.[8] 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*

Uranium, conversion, and enrichment markets are generally 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. DOE believes the

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[8] 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.

price difference between North American conversion and European conversion reflects 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 and procurement 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 449 commercial reactors operating worldwide, 99 of these are in the United States.[9] The total installed electricity generation capacity of all reactors worldwide is 392,232 MW_e (megawatt electrical), 99,869 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. 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. 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.[10]

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 enrichment are through term contracts.

A utility's procurement goal is to secure supply of nuclear fuel from reliable sources at competitive prices. When purchasing fuel, utilities generally seek bids for nuclear fuel products and services and assess those bids against the current portfolio of contracts and inventory, balancing a number of objective and subjective criteria related to security of supply as well as cost. To enhance reliability, U.S. utilities may seek a diversity of suppliers in uranium, conversion and enrichment. U.S. utilities are generally able to purchase from suppliers worldwide, subject to trade and export licensing constraints or trade remedies such as the Russian Suspension Agreement. Utility fuel purchase

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[9] *See* IAEA, "Power Reactor Information System," March 2017, http://www.iaea.org/pris/ (accessed March 24, 2017).

[10] *See* WNA, "The Nuclear Fuel Cycle," March 2017, http://www.world-nuclear.org/information-library/nuclear-fuel-cycle/introduction/nuclear-fuel-cycle-overview.aspx / (accessed April 5, 2017).)

contracts must also be consistent with U.S. non-proliferation commitments such as those in 123 Agreements and export-related regulations. There is currently no U.S. policy regarding reliance on foreign suppliers providing nuclear fuel to U.S. utilities.

2. *Uranium requirements*

As noted above, 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.

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. Unforeseen events, such as an unplanned shutdowns, can affect the accuracy of long-term projections. 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 requirements 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. Other forecasts may include these strategic or discretionary purchases – these may be referred to as "demand" forecasts.

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."

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 under future delivery contracts. Discretionary purchases are likely to be driven by spot price considerations and can constitute a large percentage of spot market purchases and thus can be a large driver of spot market price indicators. These activities mostly involve only uranium concentrates. Discretionary purchasing has a larger impact on uranium demand than demand for conversion and enrichment.

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.

i. 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. Utilities may also make strategic purchases at times of low spot prices but these rising prices may incent utilities to look at security of supply and their long-term fuel procurement plans as rising prices could signal a perception that supplies will be more scarce in the future.

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.

ii. Medium and long term

DOE expects that demand in the medium and long term is less elastic than in the short term. A change in the relative prices of uranium versus enrichment will affect the relationships between those markets by changing the optimal tails assay, potentially affecting demand in all three markets. A change in price may affect the term and type of fuel contracts that utilities seek – longer-term contracts versus shorter-term contracts and the mix of pricing mechanisms in those contracts – market-based versus fixed price or base price-escalated contracts. However, in the longer-term, these changes are not likely to affect overall requirements significantly.

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 a small portion (~19.5 percent)[11] 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.[12] Thus, among existing plants, it would take a very large increase in the cost of fuel to influence significantly a decision about whether to shut down a reactor early.

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 ERI, global supply of uranium concentrates in 2016 was approximately 198 million pounds U_3O_8. 2017 ERI Report, 11. 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. 2017 ERI Report, 10. 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.

As with enrichment, conversion supply includes both primary production and secondary supplies. For conversion services, ERI expects that total supply in 2016 was approximately 60 million kgU as UF_6, with secondary supply representing about 25%. 2017 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. 2017 ERI Report, 14.

For enrichment services, ERI expects that total supply in 2016 was approximately 63 million SWU, with secondary supply representing between 4 and 5 million SWU or about 8%. 2017 ERI Report, 17. 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

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11 NEI, *Nuclear by the Numbers* (2017), p. 9, *available at* https://www.nei.org/CorporateSite/media/filefolder/Policy/Wall%20Street/Nuclear_by_the_Numbers.pdf?ext=.pdf. 2015 generating costs are as follows: Fuel - $6.91/MWh; Capital - $7.97/MWh; Operations - $20.62/MWh and Total - $35.5/MWh.

12 Compared to a hypothetical new advanced nuclear plant, variable costs are higher for natural gas generation by a factor of 4. The only technologies with lower variable costs are geothermal, wind, solar, and hydro. Energy Information Administration (EIA), Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2016, August 2016, at 6, https://www.eia.gov/outlooks/aeo/pdf/electricity_generation.pdf.

recycle (MOX), and other commercial inventories. Id. However, a significant portion of excess supply is directed toward uranium production, reducing enrichment supply by about 10 million SWU.

2. *Global characteristics*

Many foreign governments (other than the United States, Canada and Australia) either own or exert significant control over nuclear fuel assets. Notably, all operating enrichment plants are fully or partially owned by foreign governments. U.S. suppliers are generally able to sell their products and services globally, with the key exceptions of countries such as Russia and China. For strategic reasons, Russia and China choose to power their reactors only with their domestic resources or through carefully curated strategic partnerships.

3. *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.

i. 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. This small proportion of supply is more able to respond to changes in price.

ii. 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.[13] Alternatively, 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* 2017 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 U.S. Energy Information Administration (EIA) defines spot contracts as "contracts with a one-time uranium delivery (usually) for the entire contract and the delivery is to occur within one year of contract execution (signed date)." EIA, 2015 Uranium Marketing Report, 1 (2016). EIA considers long-term contracts as "contracts with one or more uranium deliveries to occur after a year following the contract execution (signed date) and as such may reflect some agreements of short and medium terms as well as longer term." The vast majority of purchases on these markets are through term contracts. According to data from EIA, 79% of purchases of uranium by U.S. owners and operators of nuclear power reactors in 2015 were through term contracts. In addition, EIA reports that approximately 92% of enrichment services purchased by U.S. owners and operators in 2015 were through term contracts. Id. at 39. EIA does not report data on conversion contracts, but Ux Consulting Company, LLC (UxC), a private consulting firm, publishes data on spot and term contract volume for conversion services. UxC Conversion Market Outlook – Dec 2016 (2016).

[13] Louisiana Energy Services, LLC, now a subsidiary of URENCO, submitted a license 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 2019. 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. Also *See* UxC Conversion Market Outlook, December 2016.

Information regarding spot and term contracting activity for conversion services is described below in section IV.B.1.iii.

Medium-term 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. Although medium term contracts are considered "term" contracts, they 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 that sense, these contracts form an extension of the spot market to deliveries up to a few years in the future and affect uncommitted demand in these future years.

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.[14] Note, however, that the UxC and TradeTech indicators do not summarize completed transactions.[15] The UxC and TradeTech price indicators are influential as market participants may utilize market-based sales contracts that are 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.[16] UxC Uranium Market Outlook – Q1 2017, 34-36 (2017). 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.[17] Other entities, such as Uranium Markets LLC, a

[14] 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 April 13, 2017).

[15] TradeTech's Weekly U_3O_8Spot Price Indicator is TradeTech's judgment of the price at which spot transactions for significant quantities of natural uranium concentrates could be concluded as of the end of each Friday. The Ux U_3O_8 Price® indicator is based on the most competitive offer of which UxC is aware, subject to specified form, quantity(>=100,000 pounds), and delivery timeframe (<=3 months) and origin considerations and is published weekly. It is thus not necessarily based on completed transactions (although a transaction embodies an offer and its acceptance).

[16] 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, 13 (April 2017), available at http://www.uraniumparticipation.com/i/pdf/ppt/Investor-Update-April-2017.pdf.

[17] *See* CME Group, UxC Uranium U_3O_8 Futures Contract Specs, http://www.cmegroup.com/trading/metals/other/uranium_contract_specifications.html (accessed April 7, 2017).

uranium brokerage, provide the markets with a range of pricing data for specific transactions at specific timeframes and locations in order to facilitate uranium trade. These types of brokers provide additional price information to the nuclear fuel marketplace.[18]

III. Analytical approach

A. Overview

Section 3112(d) states that DOE may transfer "natural and low-enriched uranium" 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." In the 2015 Secretarial Determination and Analysis, DOE explained in detail its analytical approach to determine adverse material impact within the meaning of the statute and under the factual conditions existing at the time of a Secretarial Determination.[19] The full explanation is incorporated by reference and repeated here to the extent necessary to provide an overview of the analytical approach DOE will use in this Determination.

Of note, DOE has described transfers as having an "adverse material impact" when a reasonable forecast predicts that an industry will experience "material" harm that is reasonably attributable to the transfers. As further explained in the 2015 Secretarial Determination and Analysis, in DOE's view the proper inquiry is to what degree the effects of DOE's transfers would make an industry weaker based on an analysis reflecting existing conditions. As a general proposition, "adverse material impact" would be a harm of real import and great consequence, beyond the scale of normal market fluctuations, such as those that threaten the viability of any industry. DOE's understanding of the term "material" was shaped by the legislative history of Section 3112 and the statute's permissiveness for transfers under the Russian HEU Agreement.

DOE has interpreted the relevant terms in this analysis in advancement of the purpose of section 3112(d) to help preserve, to the degree possible, viable mining, conversion, and enrichment capacity in the United States. 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." 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.

In this analysis, DOE understands transfers to have an "impact" where those impacts have a causal relationship to the specific set of DOE transfers being considered. Thus, in assessing a given transfer, DOE will essentially evaluate two forecasts: one reflecting the state of the domestic

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[18] http://www.uraniummarkets.com/home.html (accessed April 7, 2017).

[19] 2015 Secretarial Determination, 80 Fed. Reg. at 26367; 26379 - 26383.

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 compare these two forecasts to determine the relevant and actual impacts on the domestic uranium industries.

B. Factors to be considered

In the NIPC, and consistent with the 2015 Secretarial Determination and Analysis, DOE has identified the six factors it will use in this analysis to arrive at a determination of adverse material impact.[20] Those six factors are:

1. Prices
2. Production at existing facilities
3. Employment level 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

As previously explained, 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; this list of factors serves only as a guide to DOE's analysis.

C. Comments on DOE's analytical approach

Throughout the public process initiated by the July 2016 RFI, several commenters have taken issue with DOE's understanding of what constitutes an adverse material impact under the USEC Privatization Act. For example, commenters have suggested that DOE reconsider its definition of "adverse material impact" to encompass scenarios where DOE transfers are not the primary cause of losses in one of the domestic uranium industries. See, e.g., RFI Comment of ConverDyn, at 1; RFI Comment of Energy Fuels, at 1-2; RFI Comment of UPA, at 1. Several commenters have also suggested that DOE's standard for "adverse material impact" be directly linked to production costs for the uranium mining, conversion, and enrichment markets. RFI Comment of ConverDyn, at 2. DOE has addressed these comments questioning whether this interpretation of the definition of adverse material impact is sufficient in the NIPC.[21] In the NIPC, DOE explained its position that production costs alone should not be used to determine adverse material impact, but in this analysis, DOE has considered production costs as a factor in determining whether its uranium transfers are having an adverse material impact on the market. Comments received in response to the NIPC inform DOE's understanding about production costs in the uranium mining, enrichment and conversion industries.

Furthermore, DOE has taken into account the qualitative and quantitative statements made by UPA and others in evaluating the current state of the uranium industries. E.g., NIPC Comment of UPA, at 1-2; NIPC Comment of TMRA, at 1; NIPC Comment of URENCO, at 1-3. While these

[20] Excess Uranium Management: Effects of Potential DOE Transfers of Excess Uranium on Domestic Uranium Mining, Conversion, and Enrichment Industries; Notice of Issues for Public Comment, 82 Fed. Reg. 13106, 13109 (Mar. 9, 2017).

[21] Id.

assertions provide valuable context for DOE's analysis, DOE maintains that its current interpretation of "adverse material impact" is a clear standard under which DOE ensures that the Secretarial Determination is in compliance with the USEC Privatization Act. This analysis accounts for information provided by commenters as to the six factors in the sections below.

Finally, several commenters cited the *ConverDyn* litigation (a lawsuit in which ConverDyn challenged, among other things, the 2014 Secretarial Determination) as requiring DOE to change its definition and methodology for reaching a determination on adverse material impact because the court held DOE's method to be in violation of law. *See* RFI Comment of Energy Fuels, at 1; NIPC Comment of UPA, at 5-6. As noted in the NIPC, while DOE is mindful of the results of the litigation, the *ConverDyn* litigation does not mandate a change in DOE's method of determining adverse material impact.[22]

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. In particular, DOE is assessing the impacts of transfers under two scenarios, which correspond to ERI's Base Scenario and Scenario 2 in the 2017 ERI Report. The Base Scenario consists of continued transfers at the current rate of 1,600 MTU per year, and Scenario 2 consists of transfers at a lower rate of 1,200 MTU per year. This analysis assesses the impact of continued EM transfers at these rates beginning in May 2017.[23] Because the impacts of transfers at the 1,200 MTU rate are expected generally to be lower than those under the 1,600 MTU Base Scenario rate, unless otherwise specified, in the analysis below, DOE's conclusions about the effects of transfers under the Base Scenario will bound the effects of transfers at the lower rate of 1,200 MTU.[24] Considering the difference in impacts between these two scenarios and ERI's Scenario 1, where no future EM transfers would be conducted, we come to the conclusions that transfers under either scenario would not cause an adverse material impact to the domestic uranium industries.

This assessment assumes that DOE transfers for cleanup at the Portsmouth Gaseous Diffusion Plant may continue at either the Base Scenario rate or 1,200 MTU; however, other rates of transfer are presented to provide comparison and context for the analysis of impacts on the state of the domestic uranium, conversion, and enrichment industries with and without the EM transfers. In particular, DOE tasked ERI with analyzing two additional scenarios, one in which DOE ceases

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[22] UPA highlights specific findings from the Sept. 2014 Memorandum Opinion in the *ConverDyn* case. NIPC Comment of UPA, at 5-6. DOE notes that that opinion considered DOE's approach in the 2014 Secretarial Determination, not the 2015 Secretarial Determination and Analysis, which the analytical approach described above builds upon.

[23] DOE notes that the lower rate of 1,200 MTU per year beginning in May 2017 does not precisely follow the assumption in ERI's Scenario 2, which has the 1,200 MTU per year rate beginning in January 2017. Nevertheless, DOE considers the impacts of this scenario to fall within the bounds of, and to be covered by the impacts forecasted under the Base Scenario and Scenario 2.

[24] DOE notes that for two years, 2020 and 2021, Scenario 2 involves a larger volume of transfers than the Base Scenario due to the fact that DOE's natural uranium inventory will be exhausted sooner with a higher transfer rate. DOE notes that in these two years, the effects of Scenario 2 may be higher than those under the Base Scenario. But at least for the near-term, i.e. 2017-2019, the effects under the Base Scenario should be higher.

transfers for EM beginning in 2017, and one in which DOE transfers uranium at a rate of 2,000 MTU. This assessment makes no conclusion as to whether transfers at the rates described in these other scenarios would constitute an adverse material impact on the domestic uranium industries.

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 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 EIA, the preliminary estimate of production from domestic producers in 2016 totaled approximately 2.9 million pounds U_3O_8. EIA, Domestic Uranium Production Report Q4 2016, 2 (January 2017). For comparison, the World Nuclear Association (WNA) reports that worldwide production in 2015 was approximately 157 million pounds U_3O_8.[25]

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 continuing transfers at the current level will affect prices. DOE analyzes both market prices and the prices that, on average, industry actually realizes for its products. The EIA average delivered price in the United States is representative of realized prices for the uranium industry on a global basis. Realized prices may be significant for assessing the impact of transfers, but they are not necessarily the same as market prices at any given time.

As discussed in Section II, market prices for uranium concentrates are described in terms of the spot price and the term price. Although there are other types of published uranium prices, these two price indicators are the ones most frequently used as the basis for pricing terms in contracts for the purchase and sale of uranium concentrates. In this section, we discuss the potential future impacts of DOE's transfers on spot and term prices for uranium. For reference, as of April 17, 2017, UxC's spot price indicator was \$23.50 per pound U_3O_8. As of March 27, 2017, UxC's term price indicator was [redacted] per pound U_3O_8.[26]

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 different market consultants: ERI, UPA (citing TradeTech) and Fluor-BWXT Portsmouth (FBP) (citing Capital Trade, Inc.). DOE has reviewed and evaluated to the extent

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[25] World Nuclear Association, World Uranium Mining Production, updated July 2016, http://www.world-nuclear.org/information-library/nuclear-fuel-cycle/mining-of-uranium/world-uranium-mining-production.aspx (accessed April 7, 2017).

[26] UxC, UX WEEKLY, April 17, 2017 (Volume, 31, Number 16) at 1. UxC publishes a weekly update to its spot price indicator. UxC's term price indicator for uranium concentrates and the spot and term price indicators for conversion and enrichment are updated monthly.

possible the methodology, assumptions, data sources, and conclusions of each of the market analyses.

i. Energy Resources International Report

DOE tasked ERI with estimating the effect of DOE transfers on the market prices for uranium concentrates for the period 2017 through 2026. Specifically, DOE tasked ERI with estimating the effects under four scenarios, explained below. In all four scenarios NNSA would transfer 500 MTU natural uranium equivalent of LEU from 2017 to 2019, after which NNSA would halt uranium barters. As noted above, the two scenarios assessed in this analysis correspond to ERI's Base Scenario and ERI's Scenario 2, and this assessment makes no conclusion as to whether transfers under the other scenarios would constitute an adverse material impact on the domestic uranium industries. Nevertheless, ERI's estimates of the effect of DOE transfers under these other scenarios has aided DOE's analysis.

> Base Scenario: EM would transfer 1,600 MTU in the form of natural UF_6 in 2017 and 2018, 1,569 MTU in 2019 and 559 MTU in 2020.
> Scenario 1: EM would halt uranium transfers for services between 2017 and 2026. ("No Transfer Scenario")
> Scenario 2: EM would transfer 1,200 MTU in the form of natural UF_6 per year until 2020 and 528 MTU in 2021, when UF_6 supplies are exhausted.
> Scenario 3: EM would transfer 2,000 MTU in the form of natural UF_6 per year in 2017 and 2018 and 1,328 MTU in 2019, when UF_6 supplies are exhausted.

The varying transfer rates in these scenarios refer only to the level of uranium transfers for cleanup at the Portsmouth Gaseous Diffusion Plant; the amount transferred for down-blending of LEU is constant across the scenarios. For each scenario, ERI also analyzes the impacts of transfers under the following programs: past releases of depleted uranium to Energy Northwest, future sale of depleted uranium to GLE, and potential future transfer of off-specification uranium. 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. As in previous analyses, 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 transfer displaces commercial supply. This can be estimated based on the expected schedule for delivery as reactor fuel. Thus, even though most 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. 2017 ERI Report, 22.

In the 2017 ERI Report, as in previous analyses, ERI estimated this effect by employing two different types of models that rely on somewhat different assumptions and methods: a market clearing price model and an econometric model to establish a correlation between the spot market price for uranium concentrates and active supply and demand. For its market clearing price model, ERI constructs individual supply and demand curves and compares the clearing price with and without DOE transfers. In any particular year, the market clearing price for uranium concentrates, for example, is based on the cost of production of the last increment of uranium that must be supplied by the market in order to provide the total quantity of uranium concentrates that is demanded by the market during that year. 2017 ERI Report, 2. 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 analysis, when possible. 2017 ERI Report, 44 n.33. ERI's market clearing price methodology assumes a perfectly inelastic demand curve based on its Reference Nuclear Power Growth forecast. ERI assumes that secondary supply is utilized first, followed by primary production because in an over-supplied market, such as the current market, "the amount of primary production required to meet requirements, including normal strategic inventory building, is well below actual production." 2017 ERI Report, 45.

Distinct from previous analyses, in the 2017 ERI Report, ERI applied its clearing price methodology on an annual and cumulative basis. The annual clearing price methodology is similar to past analyses conducted by ERI; the cumulative methodology represents a new approach by ERI to assess market price impacts. It is important to emphasize that, under either approach, the estimates do not constitute a prediction that prices will decrease by the specified amounts following DOE transfers under a new determination and, further, that the impact of prior transfers is already taken into account by the market in the current spot prices.

ERI's annual methodology assumes that the supply curve in a given year is independent of the DOE inventory releases in prior years. 2017 ERI Report, 49. The cumulative clearing price methodology takes into account inventory releases from prior years in the supply curve. While both methodologies account for past DOE transfers in current prices, they differ in approaches to estimating the supply side of the equation. 2017 ERI Report, 52. According to ERI, the cumulative methodology, when applied retroactively, takes into account that the reduction in one supply source can influence the behavior of other suppliers. Consequently, the cumulative methodology may show a more substantial effect than what is indicated by the annual methodology. ERI presents the impact of historical and scenario-based transfers of uranium under both the annual or cumulative methodologies. Note that ERI states that the price effects attributed to DOE inventory releases are already built into current market prices. This means that if no DOE inventory releases took place since 2009, then future market prices would be higher by the amount estimated as the DOE price effect for that given year. 2017 ERI Report, 50, 54.

DOE has considered the 2017 ERI Report and ERI's explanation of its market clearing price methodology. Most aspects of ERI's market clearing approach are essentially the same as those used in the 2015 ERI Report except that they have been updated to include recent information. With respect to the annual clearing price approach and to ERI's general approach to developing supply curve information, DOE adopts and incorporates by reference its conclusion from the 2015 Secretarial Determination and Analysis that ERI's market clearing approach methodology is reasonable for estimating the impact of DOE transfers. For this reason, DOE continues to rely on ERI's annual market clearing price approach in this Determination.

DOE has also considered ERI's explanation of its cumulative market clearing price approach. According to ERI, this approach takes account of the fact that the reduction in one supply source affects the behavior of other suppliers. In general, DOE believes that the methodology underlying ERI's cumulative model is reasonable because it takes account of the possibility that DOE uranium transfers may not in fact displace primary production in the year of the transfer.[27] Certain market actors maintain uranium inventories above requirements and may strategically hold these inventories depending on market prices in a given year. Since these inventories may add to supply in a given year, the total volume of strategic inventories potentially available to enter the market can be looked to as a proxy for expectations about market prices—likely as a supplement to published market price predictions. Thus, to the extent that DOE inventories do not displace primary production, it is reasonable to assume that they may affect decisions of uranium suppliers not just in the year of initial entry into the market, but also in *future years*. ERI does not detail how it predicts how supplier behavior would change, however. Nevertheless, DOE believes that ERI's predictions are reliable because they are based on ERI's production costs estimates, which are based on ERI's extensive collection of data about the production costs for various aspects of supply.[28]

Using the market clearing price model, under the annual and cumulative methodologies, ERI estimates of the level of price suppression attributable to DOE transfers are listed in Tables 2 and 3, respectively. Again, these numbers do not constitute a prediction that prices will decrease by the specified amounts following DOE transfers under a new determination and, further, that the impact of prior transfers is already taken into account by the market in the current market prices. 2017 ERI Report, 50, 54.

[27] In UPA's comment in response to the NIPC, UPA criticizes the ERI cumulative analysis for presenting an average impact rather than adding the price effects in each year to arrive at a total price effect as TradeTech did. Had ERI taken this approach, UPA asserts, the total cumulative impact between 2014 and 2016 would be $15.40 per pound according to ERI's analysis. For the same reasons that DOE disagrees with TradeTech's cumulative figure, explained below in section IV.A.1.ii, DOE disagrees that it is appropriate to simply add up ERI's average effect from separate years to arrive at a "cumulative impact."

[28] In addition, as noted in the 2015 Secretarial Determination and Analysis, DOE also believes that the future year supply curves that ERI utilizes in its annual market-clearing price model are reasonable because they are based on ERI's estimates of production cost for various aspects of supply. 2015 Secretarial Determination, 80 Fed. Reg. at 26386–88.

	ERI Scenario 1 – No EM Transfers	ERI Base Scenario Current Level (1,600 MTU/year)	ERI Scenario 2 Lower Level (1,200 MTU/year)	ERI Scenario 3 Higher Level (2,000 MTU/year)
2017	$0.30	$1.40	$1.10	$1.60
2018	$0.30	$0.80	$0.70	$1.00
2019	$0.60	$1.40	$1.20	$1.30
2020	$0.40	$0.60	$0.90	$0.40
2021	$0.80	$0.80	$2.40	$0.80
2022	$1.10	$1.10	$1.10	$1.10
2023	$0.90	$0.90	$0.90	$0.90
2024	$1.70	$1.70	$1.70	$1.70
2025	$2.10	$2.10	$2.10	$2.10
2026	$2.60	$2.60	$2.60	$2.60
Average (2017 – 2026)	$1.10	$1.30	$1.50	$1.30

Table 2. ERI's Estimate of Effect of DOE Transfers on Uranium Concentrate Spot and Term Prices in $ per pound U_3O_8 (Annual Market Clearing Approach)

	ERI Scenario 1 – No EM Transfers	ERI Base Scenario Current Level (1,600 MTU/year)	ERI Scenario 2 Lower Level (1,200 MTU/year)	ERI Scenario 3 Higher Level (2,000 MTU/year)
2017	$4.40	$5.50	$5.30	$5.50
2018	$3.20	$4.70	$4.50	$5.30
2019	$2.80	$5.00	$4.30	$5.30
2020	$1.10	$3.70	$3.50	$3.70
2021	$0.40	$2.70	$2.70	$2.70
2022	$0.10	$1.40	$1.40	$1.40
2023	$0.00	$2.10	$2.10	$2.10
2024	$1.60	$1.70	$1.70	$1.70
2025	$2.00	$2.30	$2.30	$2.30
2026	$0.70	$1.30	$1.30	$1.30
Average (2017-2026)	$1.60	$3.0	$2.90	$3.10

Table 3. ERI's Estimate of Effect of DOE Transfers on Uranium Concentrate Spot and Term Prices in $ per pound U_3O_8 (Cumulative Market Clearing Approach)

Although DOE believes that ERI's cumulative method is a reasonable approach to predicting the effect of future DOE uranium transfers, the specific figures listed in ERI's Tables 4.4, 4.5, and 4.6, do not isolate the effects of EM transfers in future years. It is possible to isolate the effects of these transfers based on the difference in market clearing price in any given year between a scenario with zero EM releases of uranium (Scenario 1) compared to the scenarios where EM uranium is released at different rates. In other words, we present the price effects on a marginal or incremental basis as this price effect reflects the state of the domestic uranium industry with the EM future transfers, and the state of the industry without the EM future transfers. This calculation is significant because the analysis for this Determination, at its core, answers the question of the effect on the uranium industry from future DOE transfers for EM cleanup work. That effect is evaluated by comparing the effects on markets with those future DOE inventory releases, and without those future DOE inventory releases. DOE believes it is reasonable to rely on this marginal price effect because it is itself derived from and based on ERI's cumulative market clearing methodology, which as explained above, provides a reasonable prediction of the effect of uranium transfers on market prices.

To determine the marginal price effect, DOE has used Scenario 1 as the point of reference because Scenario 1 includes the price effects from prior DOE uranium inventory releases plus an increment for the NNSA transfers. The price effects attributable to only the different levels of EM releases under the cumulative method can be found by calculating the difference between the price effect in Scenario 1 – the No EM Transfers scenario – and the price effect in these other scenarios. For example, the marginal price effect attributable to DOE transfers under the Base Scenario in 2017 would be $1.10, the difference between the cumulative price effect under the Base Scenario ($5.50) and the cumulative price effect under Scenario 1 ($4.40). Because DOE is currently transferring at 1,600 MTU per year, the current market prices already reflect the level of price suppression predicted by ERI's Base Scenario. Thus, if DOE were to transfer 0 MTU for EM in 2017, the price in 2017 would be expected to be higher by $1.10 compared to continued transfers at 1,600 MTU. Similarly, were DOE to transfer 1,200 MTU in 2017, the price in 2017 would be expected to be higher by $0.20 compared to continued transfers at 1,600 MTU (the difference between the marginal effect under the Base Scenario and the marginal effect under the 1,200 MTU Scenario).[29] Table 4 provides the price effects estimated by ERI for the varied scenarios of EM transfers under the cumulative method expressed as the marginal price effect.

[29] DOE acknowledges that these two calculations are hypothetical because DOE has already conducted several transfers in the early part of 2017. Thus, it would not be possible for DOE to transfer 0 MTU in 2017. Further, as explained above, transfers at the lower rate of 1,200 MTU would not begin until May 2017. Due to the transfers in early 2017, the total amount of EM transfers in calendar year 2017 under the 1,200 MTU scenario would actually be somewhat higher than 1,200 MTU.

	ERI Base Scenario Current Level (1,600 MTU/year)	ERI Scenario 2 Lower Level (1,200 MTU/year)	ERI Scenario 3 Higher Level (2,000 MTU/year)
2017	$1.10	$0.90	$1.10
2018	$1.50	$1.30	$2.10
2019	$2.20	$1.50	$2.50
2020	$2.60	$2.40	$2.60
2021	$2.30	$2.30	$2.30
2022	$1.30	$1.30	$1.30
2023	$2.10	$2.10	$2.10
2024	$0.10	$0.10	$0.10
2025	$0.30	$0.30	$0.30
2026	$0.60	$0.60	$0.60
Average (2017 – 2026)	$1.40	$1.30	$1.50

Table 4. Marginal Price Effect of Varied Rates of Uranium Transfers – Cumulative Method

Illustrating the marginal price effect under the cumulative methodology is useful in isolating the price effect of only the EM transfers. While useful, this approach does not account for the added effect of other future uranium transfers that will impact the market -- the NNSA transfers for down-blending, the ENW transfers of LEU, and the depleted uranium transfers to GLE and potential transfers of off-spec uranium. The annual clearing price methodology, however, does provide the combined effect of future DOE transfers in the year they are transferred. In theory, DOE could perform the same marginal or incremental analysis to the annual clearing price effects, to isolate the effects of only the EM transfers. DOE considers both approaches, which present different but complimentary perspectives on how to estimate future price effects, to be reasonable and informative. Looking at price effects from both perspectives adds an additional dimension to the analysis, and assists DOE in understanding forecasted price impacts.

As yet another means to understand the price effect, ERI presented information on the cumulative clearing price effect relative to "No DOE" clearing prices for uranium, where the "No DOE" clearing price assumes that DOE releases from 2009 onward were zero. 2017 ERI Report, 58. Table 4.7 in the ERI Report provides an assessment of price impacts going forward, for the period 2017 to 2026, and the estimated change in the uranium clearing price attributable to the DOE inventories under the four scenarios relative to the "No DOE" market prices. As in the discussion above, understanding the price impacts of the "No DOE" cumulative clearing price analysis requires a calculation of the marginal percentage change with and without the EM releases. Using the percentages from ERI's Table 4.7, Scenario 1, and comparing those percentage in each year to the other EM release scenarios. Table 5 presents the marginal price effect expressed as a percentage of market price.

	ERI Base Scenario Current Level (1,600 MTU/year) Marginal %	ERI Scenario 2 Lower Level (1,200 MTU/year) Marginal %	ERI Scenario 3 Higher Level (2,000 MTU/year) Marginal %
2017	3%	2%	3%
2018	4%	3%	5%
2019	6%	4%	7%
2020	7%	6%	7%
2021	6%	6%	6%
2022	3%	3%	3%
2023	5%	5%	5%
2024	1%	1%	1%
2025	1%	1%	1%
2026	2%	2%	2%
Average (2017 – 2026)	3%	3%	3%

Table 5. Cumulative Marginal Price Effects as Percentage of "No DOE" Clearing Price

For example, as ERI notes, under Scenario 1, where EM transfers are halted starting in 2017, average uranium prices for the period 2017-2026 would be expected to be 3% higher than under the Base Scenario (the difference between 7%, the average price suppression over the ten year period under the Base Scenario and 4%, the average price suppression over the ten year period under Scenario 1). Stated otherwise, the percentage price effect for each scenario other than Scenario 1 is the difference between the cumulative percentage for the Scenario in question and the cumulative percentage change for Scenario 1. E.g., in year 2020, prices would be 6% higher under Scenario 2 (9% - 3%).

In addition to its market clearing price models, ERI also used an econometric model to estimate the effect of DOE transfers on spot market price.[30] ERI calculated a correlation between the monthly spot prices published by TradeTech with the active spot market supply and active spot market demand, also published by TradeTech. ERI used the correlation to estimate how the spot market prices would respond to the availability of new supply from DOE. 2017 ERI Report, 61-62.

Compared to the market clearing analysis, the econometric model deals mostly with short-term supply and demand and spot prices. Applying the correlation results in an estimated spot market price effect of $5.30 per pound U_3O_8 over the last three years and a projected spot market price effect of $3.5 per pound U_3O_8 over the next 10 years. 2017 ERI Report, 61-62. This model shows a DOE price effect being higher in the near-term (2017-2020), because the price effect is on future spot market prices, which are projected to eventually rise with or without DOE inventory releases.

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[30] In its comment in response to the NIPC, UPA criticizes ERI's econometric model, noting that it is not used in ERI's overall analysis. NIPC Comment of UPA, at 8. Although it is unclear what UPA means in referring to ERI's "overall analysis," DOE notes that ERI has presented the results of its econometric model in past reports. As noted below, DOE believes ERI's econometric model is similar in certain respects to the TradeTech model.

Because this regression is based on historical trends in the spot market price series, it is most useful to provide an understanding of recent years' price effect, and provides limited reliable information about future price effects. The econometric model makes calculations based on a functional relationship between published prices and certain supply and demand variables representing, in essence, uncommitted supply and demand, to predict future prices based on the future course of the supply and demand variables. 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. DOE therefore relies on ERI's market clearing price methodology as the more reasonable approach to forecasting future price effects.

ii. TradeTech Analysis

The Uranium Producers of America (UPA) attached to its comment in response to the RFI, and re-incorporated in its comments in response to the NIPC, an analysis it commissioned from TradeTech, LLC, a uranium market consultant. RFI Comment of UPA, Attachment, "TradeTech UPA DOE Request for Information Response" (2016) (hereinafter "TradeTech Analysis"). UPA also included in its comments on the NIPC additional critique of the ERI Report.

The TradeTech Analysis provides information on spot prices for uranium since 2011, after Fukushima, indicating a decline in prices of 60 percent as of mid-July 2016. TradeTech Analysis, at 4. TradeTech presents an estimate of the cumulative impact of DOE transfers on the Exchange Value (TradeTech's monthly U_3O_8 spot price) over the period of 2012-2015. TradeTech presents the median impact in each year of this period as follows: $2.79 in 2012, $3.81 in 2013, $4.18 in 2014, and $6.17 in 2015. TradeTech then presents the "total cumulative impact from DOE transfers 2012-2015" as $16.95 per pound, a figure evidently calculated by adding together the median impact for each year in the time period. More generally, TradeTech explained there is a downward trend in recent years for uranium production and demand, producer profit margins, and long-term contracting practices. Without citing to any additional quantitative analysis or modeling, TradeTech concludes that DOE material transfers entering the spot market will continue to have a measurable adverse material impact on uranium market prices and, by extension, uranium producers. TradeTech believes that if DOE were to cease its transfers, producers would see improvement in the market. TradeTech Analysis, at 8.

TradeTech does not explain the methodology it used to estimate the impact of DOE transfers. For the purposes of this analysis, DOE assumes that the estimate is based on the same Dynamic Pricing Model described in a 2015 TradeTech report submitted in response to the 2015 Request for Information on the 2015 Secretarial Determination. To the extent that the 2017 TradeTech Analysis is based on a similar model, DOE adopts its conclusions with respect to that model from the 2015 Secretarial Determination and Analysis. That is, the TradeTech model is similar to the methods ERI uses in its econometric approach, which may provide a reasonable estimate of the price response under short-term conditions, but it is not an accurate prediction of the effect of future DOE transfers. Although TradeTech does not forecast the effects of future transfers, UPA suggests that future transfers will have an impact equal to at least the median impact in 2015—i.e. $6.17. Alternatively, UPA suggests that that impact can be expected to continue rise at rate of roughly 30% each year—i.e. $8.10 in 2016, $10.64 in 2017, and $13.97 in 2018. *See* RFI Comment of UPA, 5.

DOE does not believe these numbers are accurate, and that UPA incorrectly assumes that trends evident in TradeTech's model of *past transfers* would automatically carry forward into future years. In any case, even if TradeTech had prepared a forecast of the impacts of future DOE transfers, DOE believes that ERI's market clearing model is a more reasonable approach to estimating medium- and long-term effects.

With respect to the "cumulative" figure presented in Figure 3 of the TradeTech Analysis, neither TradeTech nor UPA attempts to justify the economic principles behind this approach. DOE does not believe it is appropriate to simply add the median impacts in successive years to determine the "cumulative" impact for at least three reasons. First, it is unclear why the time period should be divided by year rather than, say, quarterly, monthly, or even weekly or daily. If it is appropriate to add the median impact in successive years, it follows logically that it is also appropriate to add the median impacts across other time periods. This would lead to the illogical result that the "cumulative" impact could be the sum of the average price impacts for each individual day in the study period.

Second, TradeTech's own chart does not support the assertion that DOE transfers have suppressed the market price by $16.95. Figure 3 of the TradeTech Analysis charts in linear form the actual market price versus the expected price with no DOE transfers. At the end of the study period, the difference between the lines on the figure appear to be roughly the same as the 2016 median impact—i.e. roughly $6.00—rather than the larger number presented as the cumulative impact.

Third, the figures cited by TradeTech and UPA do not align with recent market dynamics. Considering that DOE transfers are less than 5% of worldwide requirements, this number is unrealistically large. Applying the approach suggested by UPA and TradeTech of adding together the expected price suppression in 2015 and 2016 based on ERI's price forecast would yield a "cumulative" price effect of $10.50 per pound compared to the overall price decline in that same period reported by ERI of roughly $17 per pound. If this were correct, it would mean that DOE's transfers alone accounted for over 50% of the price decline, even though DOE's transfers in that same period made up only about 15% of the total domestic uranium requirements and 5% of worldwide requirements. Furthermore, UPA claims that the cumulative impact of DOE transfers from 2012 to 2018 will reach $49.64. These numbers are simply too large to be realistic. While DOE understands that in an oversupplied market, as has been the case in recent years, secondary supply sources may be used before primary supply sources, it is not reasonable to conclude without further support that the total cumulative effect of DOE transfers account for more than half of the market price decline, given other market factors at play, e.g., the early closure of nuclear power plants in the U.S. and Western Europe, and the reduction of nuclear energy in France based on legislation passed in 2015. 2017 ERI Report, 4. For these reason, DOE believes the cumulative approach of UPA and TradeTech of simply adding each median annual effect together does not present an accurate assessment of price effects from DOE transfers.

iii. Capital Trade Inc. Analysis

FBP attached to its comments in response to the NIPC an analysis it commissioned from Daniel Klett, an economist and principal with Capital Trade, Inc. NIPC Comment of FBP, Attachment, "Review of ERI Price Effect Estimates for Uranium Associated with DOE Inventory Releases," (2017) (hereinafter "Capital Trade Analysis"). As explained by FBP, ERI's use of the cumulative price clearing methodology found larger price effects by including not only inventories sold into the market by DOE each year, but also "inventory overhang" price effects associated with DOE inventories held by users. NIPC Comment of FBP, at 3. The Capital Trade Analysis commissioned by Fluor argues that this approach is flawed for numerous reasons and is without a theoretical basis in economics. Capital Trade Analysis, 5. The Capital Trade Analysis concludes that DOE should continue to rely on ERI's annual methodology for estimating the price effects of DOE inventory releases. Capital Trade Analysis, 7.

The Capital Trade Analysis makes three essential arguments. DOE believes Capital Trade has misunderstood ERI's cumulative approach. DOE continues to believe that ERI's cumulative method is reliable, and therefore, that DOE's use of ERI's cumulative market clearing price information to calculate the marginal price effect of future EM transfers is reasonable. DOE also continues to believe, and agrees with Capital Trade, that ERI's annual methodology is a reasonable approach and should be relied upon for estimating price effects.

First, Capital Trade argues that ERI's cumulative methodology "violates" the principle that price equals marginal cost. This position appears to be based on a misunderstanding of ERI's cumulative methodology. ERI's cumulative methodology, as compared to the annual methodology, involves adjusting the supply curve in each year to take account of supply and demand conditions in prior years. This accounts for the possibility that the volume a particular supplier may be able to supply at a given price is dependent on investment decisions made in prior years. In this manner, a change in supply in one year can affect the supply curve in later years to the extent that it influences the investment decisions of the suppliers that would otherwise make up the supply curve in future years. ERI's cumulative approach simply takes this elasticity of supply into account in developing estimates of future supply curves. In all cases, the market clearing price would continue to be determined by the intersection of the demand curve and the supply curve, i.e. the marginal cost of production of the last unit supplied.

Second, Capital Trade argues that the "inventory overhang" effect may affect the timing of price effects but not the magnitude. As explained above, DOE believes that in referring to "inventory overhangs," ERI is taking account of the possibility that not all DOE transfers displace primary production. Certain market actors may hold uranium inventories in excess of reactors requirements for reasons such as strategic investment or to guarantee security of supply. These strategic inventory holders decide how much to hold in reserve based at least in part on market prices. Because inventories held in excess of requirements can potentially reenter the market in future years, perceptions about the total size of such inventories may affect supplier (and purchaser) investment decisions. To the extent that DOE transfers do not displace primary production and instead add to the total volume of reserves in excess of reactor requirements that are potentially available to enter the market in future years, that addition to secondary supply could conceivably have price effects that are *both* delayed and magnified to the extent that suppliers look to the total volume of reserves held in excess of requirements in making investment decisions.

Third, Capital Trade states that ERI is unclear and inconsistent with regard to when and how a particular volume has an effect on market price and that ERI does not explain how the shutdown of primary mines factor into the cumulative methodology. DOE acknowledges that ERI has declined to provide specific information regarding its estimates of supply curves in future years. ERI explains that it develops its proprietary supply curves based on available information on costs facing each individual supply source from publicly available sources, including public filings from various mining companies, and evidence of how suppliers have responded to changes in the past. DOE believes that ERI's approach to estimating production costs would yield reliable predictions of supplier behavior. To the extent that ERI predicts primary mine shutdowns, these would be accounted for in the supply curves that ERI builds for each year in order to determine market clearing price.

For these reasons, DOE believes that ERI's cumulative method is reasonable, and therefore, it is appropriate for DOE to rely on the cumulative marginal price effects of EM transfers predicted by ERI's cumulative method.

iv. Effect of DOE transfers on market prices

Based on the foregoing discussion of market analyses and DOE's consideration of the information, DOE concludes that pursuing the level of EM transfers under the Base Scenario will suppress the market price of uranium concentrates in the next decade by an average of either $1.30 or $1.40 per pound U_3O_8, based on the annual clearing price approach or the marginal cumulative clearing price approach, respectively.

As described in Section II.a.i, both the annual and the marginal cumulative clearing price projections provide valuable and complementary insight into the future price effects of DOE transfers. As in the past, DOE relies on ERI's annual market-clearing approach to assess the impact of future DOE transfers. Now, DOE also relies on the marginal cumulative market-clearing approach to assess the effect of future EM transfers. After analyzing these estimates, DOE bases its conclusions here on the larger projected price effect of the transfers on average over the next decade—the cumulative marginal market-clearing price effect of $1.40 per pound U_3O_8. This estimate is close to the average price effect for the near-term time period - from 2017 through 2019 – of $1.20 (annual) or $1.60 (cumulative marginal) per pound U_3O_8. Further, if DOE transfers are conducted at the lower Scenario 2 rates, this would create a lesser suppression on market prices as compared to transfers under the Base Scenario in the near-term of roughly $1.00 (annual) or $1.20 (cumulative marginal) per pound U_3O_8, the difference from 2017 to 2019 between the Base Scenario and Scenario 2 under the annual and marginal cumulative methods, respectively.

The significance of price suppression at this level depends, in part, on current and forecasted market prices. Recent spot and term price indicators published by UxC for the first quarter of 2017, were $23.50 per pound U_3O_8 on the spot market as of April 17, 2017 and [redacted] per pound U_3O_8on the term market.[31] The forecast price effect reasonably attributable to DOE transfers under the Base Scenario based on the marginal cumulative approach ($1.40) represents 6% and 4% of current spot and term prices, respectively. This percentage change is similar to the percentage change anticipated in the 2015 Determination for prices relative to the existing spot and term prices at that time – 6.8% and 5.5%, respectively. And, a similar result is shown in Table 4, which reflects in 2017 a 3% marginal cumulative price effect for DOE transfers in the Base Scenario under the "No DOE" clearing price approach.

Moreover, this price effect is within the range of market fluctuations experienced in the uranium industry in recent years. ERI's statistical model of price volatility on an annualized basis (as shown in Figures 4.34 and 4.35) illustrates the conclusion that historical price volatility is noticeably higher for the uranium and conversion markets than for the enrichment market over the long term, although

[31] UxC Nuclear Fuel Price Indicators, Weekly Spot Ux U_3O_8 Prices as of April 17, 2017, https://www.uxc.com/p/prices/UxCPrices.aspx (accessed April 17, 2017).

enrichment term price volatility has been higher and conversion term price volatility has been lower in recent years. 2017 ERI Report, 94-96. Even in the last three years, the U_3O_8 price has experienced significant volatility, with annual price volatility increasing during 2014 and 2016. For example, the spot prices of uranium from January 2015 to December 31, 2016, went from a 46% decline to a 21% increase from December 31, 2016, to the current March 2017. Term prices for uranium also have experienced a range of price changes, with a decrease of 40% between January 2015 and December 31, 2016, to an increase of 3% from December 31, 2016, to March 2017. Price effects that are in the range of 6 and 4 percent are not substantial or outside historical experience in the uranium markets.

DOE believes that it is appropriate to compare the price effect in future years to forecasted market prices in those years. Using near-term projected market clearing prices from ERI's Nuclear Fuel Cycle and Price Report December 2016 Update (at 4-17) [redacted] DOE calculates that the average price effect of planned DOE transfers under the Base Scenario assuming a price effect of $1.40 per pound would cause an average percent decrease in the near-term of 6% per year. Looking at a 10-year average of forecasted prices from this same report yields a 4% impact from the DOE transfers' projected price effect. While ERI's market-clearing price effect is not intended to be a direct price forecasting tool, using the ERI Reference Case price forecasting data allows us to derive an approximate percentage future effect. This is also another mechanism to compare the average percentage cumulative marginal effect projected by ERI for the same time period.

v. 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 price indicators published by TradeTech and UxC are based on information about recent offers, bids, and transactions. This information 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.

As previously noted, most deliveries of uranium concentrates take place under term contracts. According to data from EIA, 79% of purchases of uranium by U.S. owners and operators of nuclear power reactors in 2015 were through term contracts. EIA, 2015 Uranium Marketing Report, 1 (2016). UxC data indicates that spot contracts made up [redacted] of total contracting volume in 2016, and term contracts [redacted].[32] U.S. utilities, in particular, have increasingly tended toward mid-term contracts. UxC Uranium Market Outlook – Quarter 1 (2017), 27.

ERI assumes that 50% of the NU that EM transfers is introduced through spot markets and 50% through term market contracts. 2017 ERI Report, 38. If this assumption is not exact and more or less than 50% of DOE transfers for Portsmouth cleanup 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

[32] [redacted] UxC Uranium Market Outlook – Quarter 1 (2017), ii.

ERI's assumptions would simply decrease the reliability and certainty of ERI's econometric forecast in the mid- to long-term. As described above, DOE concludes that ERI's econometric analysis is likely to be less reliable over the longer term anyway, because predictions about uncommitted supply and demand in future years are uncertain.

The actual effect experience by a primary producer would be the proportionate change in its realized prices. FBP and UPA, in comments, have provided information on realized prices. In its comment on the RFI, FBP noted that Peninsula Energy, parent of Strata Energy, signed four contracts from 2011 through 2016 for a total of 8.2 million pounds at an average price of over $54 per pound; UR Energy reported contracts with deliveries from 2016 through 2021 with average prices of $49.81 per pound, and Energy Fuels reported sales of 1.1 million pounds in 2015 at an average price of $56 per pound. NIPC Comment of FBP, at 13. Conversely, TradeTech reported that in 2015, 21 percent of uranium concentrates was purchased under spot contracts at a weighted average price of $36.80 per pound. RFI Comment of UPA, at 5. TradeTech cites EIA figures showing that 6 percent of U.S, utility purchases were of U.S.-origin in 2015, at a weighted-average price of $43.86 per pound, 5 percent below the weighted-average price for all purchases. RFI Comment of UPA, at 6. TradeTech opines that this decline is part of a larger trend in realized prices, and is expected to continue as legacy contracts signed over the last 10 years are fulfilled. Id. EIA reported in 2015 realized prices of $42.91 per pound. Id. at 7.

Table 6 provides data on sales and realized prices for U.S. uranium producers in 2016 from public filings. The data in Table 6 demonstrate that several of the producers obtained a realized price above the 2015 realized price cited by EIA. Although realized price data was not available for Energy Fuels, a statement from its SEC 10-K form indicates that "[t]hree of our four supply contracts contain favorable pricing above current spot prices." Energy Fuels Inc., Management's Discussion and Analysis, Year Ending December 31, 2016, at 119 (Dec. 2016). New long-term and mid-term contracts among all U.S. uranium producers are likely to have similarly high prices relative to the spot market.

Information from Public Filings		
Producer	**2016 Sales (lbs U_3O_8)**	**Realized Price**
Uranium One[33]	56,100	$27
Ur-Energy[34]	22,191	$41.38
Cameco[35]	N/A	N/A
Energy Fuels[36]	1,147,933	$47.42
Uranium Energy Corp.[37]	N/A	N/A

Table 6. Reported Sales and Realized Price by U.S. Producers

To the extent that contracts have floor price provisions, the prices realized by producers may not fully reflect any market decline. 2017 ERI Report, 71. [redacted] UxC Uranium Market Outlook – Quarter 1 (2017), at 31. Realized prices and the exposure to the spot market in the U.S. uranium industry vary between companies. ERI reports that the share of U.S. production coming from companies that are effectively unhedged (no long-term contracts with higher fixed prices) has declined from about 25% in 2012 and 2013 to about 3% in 2015 and 2016. 2017 ERI Report, 73. ERI emphasizes, however, that it does not appear that removing the DOE inventory from the market and adding back the cumulative price effect attributed to the DOE inventory material in 2016 in the Base Scenario would necessarily increase current prices enough to markedly change the realized prices for new production centers in the U.S. 2017 ERI Report, 73-74.

EIA provides data about sales using different pricing mechanisms. EIA reports that of the approximately 19 million pounds U_3O_8 equivalent purchased by U.S. reactor operators from

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[33] These figures represent sales through Dec. 31, 2016. Uranium One operates the Willow Creek mine in Wyoming. Uranium One Inc., Operating and Financial Review, 4, 16 (Dec. 2016), *available at* http://www.uranium1.com/index.php/en/investor/financial-reports-and-filings/annual-reports.

[34] UR-Energy operates the Lost Creek ISR mine in Wyoming. UR-Energy Inc. Form 10-K, Securities and Exchange Commission, at 49 (Mar. 3, 2017) https://www.sec.gov/Archives/edgar/data/1375205/000155837017001345/urg-20161231x10k.htm (accessed April 11, 2017).

[35] Cameco operates the Smith Ranch-Highland (Wyoming) and Crow Butte (Nebraska) ISR mines. Cameco, Annual Report 2016, Management's Discussion and Analysis, at (Feb. 9, 2017), https://www.cameco.com/invest/financial-information/annual-reports/2016.

[36] Energy Fuels operates the White Mesa conventional mill in Utah, the Nichols Ranch ISR mine in Wyoming, and the Alta Mesa Project in Texas. Energy Fuels Inc., Management's Discussion and Analysis, Year Ending December 31, 2016, at 4 (Dec. 2016), *available at* http://www.energyfuels.com/wp-content/uploads/2017/03/2016.12.31-10K-FINAL-Reduced-Size.pdf

[37] Uranium Energy Corp. (UEC) operates the Hobson/Palanga ISR mine in Texas. UEC reports that as of July 31, 2016, it had no uranium supply or "off-take" agreements in place. 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 6, 72 (Dec. 2016), *available at* https://www.sec.gov/Archives/edgar/data/1334933/000127956916004485/v449966_10k.htm.

domestic sources[38] and delivered in 2015, 13.9 million pounds were purchased based on fixed or base-escalated pricing—approximately 73%—with a weighted-average price of $40.34. Approximately 876,000 pounds were purchased based purely on spot-market pricing—approximately 5%—with a weighted-average price of $38.22. The remaining 3.9 million pounds—approximately 21%—was sold based on some other pricing mechanism with a weighted average price of $53.59. EIA, 2015 Uranium Marketing Annual Report, 22-24 (2016). DOE understands that the realized prices received for natural uranium in the last year have been lower than in the several previous years. However, the long-term forecasts do not indicate that this steep decline will continue.

Given that ERI reports that essentially all U.S. producers have at least some long-term contracts with fixed prices above the spot market price[39] and that the average realized price continues to be above the current spot price, it appears that the domestic uranium industry is somewhat insulated from the impact of DOE transfers on uranium prices. In particular, price suppression attributable to DOE transfers under either scenario does not have a significant effect on preexisting, long-term contracts that were entered into at higher prices. That said, DOE transfers will have an effect on the contract price for spot and term contracts entered into in the future. For those contracts, and as explained above, the anticipated effect of EM transfers is expected to be relatively small—approximately 6% of expected near-term prices—and well within the range of normal market price fluctuations.

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, and the relationship between market prices and production costs.

EIA reports data on production levels in the domestic uranium industry on a quarterly and annual basis. According to EIA, U.S. primary production in 2015 stood at 3.34 million pounds U_3O_8. EIA's most recent quarterly report provides preliminary data for 2016. EIA's preliminary figures for 2016 indicate that U.S. production of uranium concentrates declined 13% from 2015 production to 2.92 million pounds U_3O_8. ERI's projection that 2016 U.S. production was expected to decline below 3.0 million pounds is consistent with EIA's preliminary data. 2017 ERI Report, 68. U.S. uranium production peaked in 2014 at 4.9 million pounds. Although there were a number of new starts that were spurred by the price run-up in 2006 and 2007, a number of these facilities have limited production in response to the decline in prices since that time.

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[38] 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, 2015 Uranium Marketing Annual Report, 22 (2016).

[39] 2017 ERI Report, 121.

In 2016, Cameco halted new wellfield development at its Crow Butte and Highland/Smith Ranch centers, which resulted in a production decline of 36% from 2015 levels. Production at the Highland/Smith Ranch center is expected to further decline by more than 50% in 2017. Cameco's curtailment at its U.S. properties follows Willow Creek, Palangana, and Alta Mesa halting new wellfield installation in 2013 and 2014, resulting in minimal or no production from these facilities in 2015 and 2016. ERI reports that Energy Fuels' White Mesa mill operated at low levels, processing alternative feed material and stockpiled ore from prior conventional mining in Arizona. ERI further reports that newer in-situ recovery projects at Nichols Ranch and Lost Creek held production steady rather than continue to ramp up to planned levels. Peninsula's Lance ISR project (part of the Ross permit area) began operation in late 2015 and began shipping drummed uranium for conversion services in mid-2016. ERI suggests that these production trends will continue into 2017 although Lance is expected to add some production. 2017 ERI Report, 7.

EIA reports that the same number of uranium concentrate processing facilities—seven—operated in 2016 as in 2015. In 2016, production from Hobson/Palangana ceased, while production from the Ross Central Processing Plant/Lance began. EIA Domestic Uranium Production Report Q4 2016, 4–6 (January 2016).

ERI presents a figure (Figure 4.24) showing various industry contracting and production events as compared to both the spot and term price of uranium. 2017 ERI Report, 74. That figure shows that most new U.S. production was supported by long-term contracts in the range of $55 to $70 per pound. However, one producer entered into contracts when long-term prices were in the $45 to $50 per pound range in late 2014 to early 2016, which allowed new operations to begin. ERI notes that, "At least one of these companies has stated that the project would not have been able to proceed if the initial contracts had been made at then-current price levels ($45 to $50 per pound long-term)." 2017 ERI Report, 73. In March 2017, Energy Fuels Resources received all licenses, permits and approvals permits to allow wellfield development at its Jane Dough property, an expansion of its currently-producing Nichols Ranch property. Energy Fuels opined that, "Uranium spot prices are up over 40% since early December 2016, and we are optimistic that we will continue to see positive market catalysts as the year goes on. As uranium prices continue to rise on a sustained basis, we expect to resume wellfield construction at Nichols Ranch, which is expected to include the Jane Dough wellfields in the future." It has been reported that a company official said that Energy Fuels will consider production from Jane Dough after spot prices reach the $40/pound U_3O_8 level.

ERI's Figure 4.24 also shows the price levels at the time cutbacks were announced by various U.S. suppliers. This graphic depicts price points for cutbacks at select operations: $45 per pound in the spot market for conventional mines in Utah; $40 per pound in the spot market for an-situ-leach operations; and $35 per pound in the spot market for an additional in-situ leach operation and conventional mines, as well as a uranium mill. As prices declined to less than $30/pound in early 2016, Cameco halted all new U.S. well field development, as noted earlier in this section. 2017 ERI Report, 74.

ERI 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 remained fairly constant from 2009 to 2012 at about $40 per pound. However, EIA reports that average production costs have declined since that time as U.S. producers curtailed operations at some higher cost mines. Using the EIA data, ERI calculates a three-year average production cost for $31/pound in 2015. 2017 ERI

Report, 75. ERI further reports that it estimates average production costs at U.S. in-situ-leach facilities, which includes exploration and development drilling costs needed to keep the mine producing, at $37/pound in 2015, and expects that this will decline further to $35/pound in 2016. 2017 ERI Report, 76.

UxC has developed and reported upon production cost data in its Uranium Market Outlooks and a 2015 Production Cost Study. UxC Uranium Market Outlook, Q1 2016 (2016); UxC Uranium Production Cost Study (2015). UxC developed a production cost curve for operating projects that assumes a [redacted]% return. UxC describes the forward costs estimates as "the minimum sales price a producer might accept under a new contract if recovery of sunk costs is not required." UxC divides the various production centers into cost bands. [redacted] UxC, 2015 Production Cost Study, 92.

Actual production levels and costs are usually proprietary information, so DOE must generally rely on estimates. ERI's estimates and UxC's estimates are generally consistent, given what we know about efficiency improvements at some facilities and operational changes in others as wellhead development slowed or ceased. In 2015, DOE found that the production cost estimates from TradeTech, NAC, and UxC were all generally consistent with ERI's conclusions. ERI utilized the same methodology in 2017. We consider that ERI's analysis is likely in line with other market experts.

ERI also reports that while the spot uranium price averages $36.76/pound in 2015, it averaged less than $26/pound in 2016. The term and spot prices reported by UxC at the end of March 2017 are below the estimated production cost for in-situ properties as well as the U.S. average for all properties. However, the relationship between current production decisions and prices is also affected by the contract portfolios of various uranium producers and how much they are exposed to the spot market. ERI estimates that the share of U.S. production coming from companies that are effectively unhedged, with no long-term contracts at higher prices, has declined from about 25% in 2012 and 2013 to just 3% in 2015 and 2016. 2017 ERI Report, 121.

In addition to prices, production decisions are also related to company-specific production strategies such as Cameco's decision to limit its production to its three most efficient large mines in Canada and Kazakhstan. One commenter opined that even if EM's transfers are eliminated, that the level of U.S. production would not increase because U.S. uranium production is less competitive than other mines so producers would ramp up production at their most efficient mines outside the U.S. first. That commenter also noted that if the 2015 percentage of U.S. to non-U.S. supply is applied -- EIA reports that 94% of the uranium delivered to U.S. utilities in 2015 was foreign origin -- to replace supply displaced by DOE inventory, then the resulting increase in U.S. sales would be a very small amount. RFI Comment of FBP, at 6-8.

Based on the spot price at the end of March 2017, it does not appear that adding the estimated incremental $1.40 impact of EM transfers at the Base Scenario levels as compared to no EM transfers back to that spot price would incentivize additional U.S. production. ERI states that term prices would still be below the level required for new conventional production to move forward, but notes that some lower cost in situ production may be able to move forward at current term prices.

In addition, realized prices of U.S. producers were presented in the previous section. It does not appear that the incremental $1.40 change in spot price between no uranium transfers by EM and transfers at the current rate would cause realized prices to be below production costs at any particular facility, especially with the limited number of companies that remain unhedged. DOE recognizes that receiving prices barely above production costs would not provide enough return to justify investing in production, as a producer requires a certain amount of expected margin. Even considering a small effect on the margin, DOE concludes that ceasing EM transfers entirely would not cause U.S. producers to increase production levels substantially in the near-term.

Some NIPC commenters reported that they had to reduce production levels in response to low uranium market prices. UPA indicated that domestic production had declined from 4.9 million pounds in 2014 to 2.9 million pounds in 2016. Comment of UPA, at 13. DOE recognizes that production levels are lower but not in their entirety attributable to DOE transfers. DOE believes that it is an appropriate implementation of the analytical approach discussed above to compare the likely state of affairs with the considered transfers and without the considered DOE transfers in order to understand the impact reasonably attributable to its transfers. DOE has drawn this comparison in concluding that continuing transfers under the Base Scenario would not result in U.S. production being markedly lower than it would in the absence of DOE transfers.

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 625 person-years in 2015, a 21% decrease from the 787 person-years in 2014. EIA, 2015 Uranium Production Report, 10 (May 2016). EIA notes that this is the lowest level since 2014. Exploration employment was 58 person-years, down from 86 in 2014 and 149 in 2013, a 33% and 61% drop respectively. Mining employment was 251 person years, an increase of 2% from the 246 level of 2014 but a 36% decline from the 2013 level of 392 person-years. Milling and processing employment decreased 32% from 2014. EIA further reports that reclamation employment declined 28% to 116 person-years from the 2014 level of 161 person-years, and 42% from the 199 employed in reclamation in 2014, a 12-year high. Employment for 2015 was in nine states: Arizona, Colorado, Nebraska, New Mexico, Oregon, Texas, Utah, Washington, and Wyoming.

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, observing that mining, milling and processing employment was more closely correlated with term price and exploration employment with spot price. 2017 ERI Report, 64-65. ERI then uses this correlation to estimate that the decrease in uranium prices over the course of 2012-2015 resulted in employment lowered by an average of 30 person-years or that employment was 3.1% lower in those four years than if no releases had occurred. Using the cumulative methodology, the correlations indicate than the DOE transfers lowered employment by an average of 73 person-years during 2012-2015, or lowered by 7.2%. 2017 ERI, 66.

Looking forward, ERI correlates employment and price over the 10-year period 2017-2026 for the Base Scenario, which represents the current rate of EM transfers, and estimates an average loss of 19 person-years or a 2.9% reduction in employment over the ten-year period. The cumulative method yields an employment loss of 40-person-years or 6.0% over the 10-year period. Using the cumulative methodology, under Scenario 1 (halting EM transfers), employment would still be lowered by an average of 31 person years or 4.7 %. Thus, the marginal employment effect based on the cumulative methodology between EM transferring uranium at current levels versus not transferring uranium is a change in average employment over the next ten years is 9 person-years, or 1.3%. It is important to note the cumulative effect of past releases is already in place and that transfers that occurred in past years will continue to have an impact in future years.

Using their employment-spot price correlation, ERI estimates that uranium industry employment is expected to decline by an additional 111 person-years from the 2015 level. ERI opines that this is consistent with announcements that have been made in the domestic industry. 2017 ERI, 65.

Some commenters stated that the uranium production industry has lost half its workforce since May 2012. RFI Comment of Energy Fuels, at 3; RFI Comment of Uranium Producers of America, at 4. EIA figures demonstrate a 48% loss in employment from 2012 to 2015. EIA Uranium Production Report (May 2016), 9. However, for predicting the effect of DOE's transfers it is important to understand what portion of recent employment decreases is reasonably attributable to past DOE 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 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 and premature closure of nuclear plants.

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 fluctuations in market conditions that have taken place in that period. The relatively small price effects likely to result from DOE's transfers are much smaller than the price 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/contracting structure and realized prices. Aggregated over producers, the result would be the sort of correlation between prices and employment that ERI observes.

Several NIPC commenters indicated that they had been forced to reduce employment levels due to continued weakness in the uranium markets. UPA in their comment at 15 noted that employment fell by 45.9% (531 jobs) from 2013 to 2015 and that in 2016 several UPA members announced they were anticipating further employment cuts. While industry did not predict the impact of future DOE transfers, as noted above, based on ERI's cumulative methodology, the marginal effect of EM transfers on employment is expected to average 9 person-years or 1.3% over the next 10 years. Given the size of recent employment fluctuations and the size of future expected changes (in the 100s of person-years), this effect is well within the range of existing fluctuations. Further, the employment effect of DOE transfers is not expected to be large enough to negatively affect the retention of intellectual experience and "know-how" in the industry.

4. *Changes in capital improvement plans and development of future facilities*

As stated above, ERI reports that five new production centers began operation since 2009: two in 2010, one in 2013, one in 2014, and one in 2015 2017 ERI Report, 67. 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 if the initial contracts had been made at the then 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 or more per pound would be necessary for further development. 2017 ERI Report, 73.

EIA reports that U.S. uranium production expenditures were $119 million in 2015, down by 14% from the 2014 level. EIA reports that uranium exploration expenditures were $5 million and decreased 56% from the 2014 level. EIA, 2015 Domestic Uranium Production Report, 2 (2016). ERI looked at the average production cost plus development drilling costs, to show that ongoing costs have declined from $49/pound in 2012 to $37/pound in 2015. Production plus development costs for U.S. facilities are expected by ERI to average about $35/pound in 2016. 2017 ERI Report, 76.

Based on the above, ERI concludes, "it does not appear that removing the DOE inventory from the market and adding back the $5 per pound cumulative price effect attributed to the DOE inventory material in 2016 … in the Base Scenario would necessarily increase current prices enough to change the situation regarding the viability of new production centers in the U.S., that is, current spot prices would remain less than $30 per pound and current term prices would still be less than $40 per pound." ERI goes on to suggest that higher price signals appear to be required to move forward with the development of new conventional mines in the U.S but notes that some lower cost ISL projects may still be able to move forward at current term prices (which include the DOE inventory price effect). " 2017 ERI Report, 73-74.

In the UxC Uranium Production Cost Study (2015), UxC refers to facilities that are "planned" and that are "potential." UxC notes that, [redacted] UxC also notes that planned projects have higher risks than operating projects, which would necessitate higher rates of return. UxC Uranium Production Cost Study, 60. UxC states that there is a lower level of confidence in estimates about potential facilities. In addition, UxC states that [redacted]." UxC Uranium Production Cost Study, 62, (2015). As an example of some of the difficulties facing potential facilities versus planned facilities, UxC refers to a potential project in Virginia, where there is a statewide ban on uranium production.

UxC divides the planned and potential projects into cost bands. According to UxC, [redacted] We believe that some of the differences between ERI and UxC may be attributable to the assumptions regarding the construction of production cost factors, such as reclamation costs, and the fact that UxC's 2015 report does not take account of efficiency improvements at some facilities in the last 18 months.

DOE's task is to assess what the state of affairs would be with and without the planned transfers. DOE believes that industry reports such as UxC's, which provide data about the expected costs of actual projects, provide an additional foundation upon which to conduct its analysis. Since uranium prices decreased in the recent past, it is not surprising that producers have reduced their activities to develop new resources, as reflected in the EIA data. However, consistent with the analytical approach described above, the relevant question is what will be the effect on these activities of DOE transfers in the future.

DOE believes that one approach is to compare the expected market price with and without DOE transfers to estimated production costs at potential new production centers. The incremental impact of $1.40 per pound under the Base Scenario as assessed by DOE does not appear to markedly change decisions whether to develop future production centers. On this basis, 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.

Furthermore, DOE believes that future capital projects and production decisions are more likely to be based on future expectations about market prices, which we believe are tied closely to an expected increase in demand and the impact of recent production cutbacks, as well as contracting trends, rather than on a straightforward comparison of current market prices to production cost. New production centers are a long-term investment, and new facilities require several years of lead-time before production can begin. Many producers are unwilling to bring a new facility into production without long-term supply contracts in place that reflects expected market conditions.

Additionally, as a long-term investment, the outlook for financing any development or expansion of uranium projects should be tied to the long-term expectations for growth in nuclear power. However, the current outlook for certain plants facing premature closure, due in part to electricity market challenges, has colored the near-term outlook of investors and may have made financing these projects more challenging. Market capitalization is representative of a company's ability to raise funds needed to move a project through licensing, which can take many years, as well as through initial project development. ERI observed that the market capitalization of the smaller mining companies is more sensitive to changes in the spot market price compared to the larger companies. 2017 ERI Report, 70.

Some NIPC commenters indicated the necessity to suspend development plans or to limit production expansion. One indicated it was deferring well-field development. Another commenter noted a drop in EIA's reported development and exploration expenditures and suggested these numbers be used as a proxy to measure corporate decisions on capital expenditures. DOE believes the overall market pricing condition is the most significant driver for capital development plans.

Based upon our analysis of price effect of future transfers, DOE does not believe that its near term future transfers will have an adverse material impact on uranium mining industry development plans.

DOE concludes that transfers at the Base Scenario level, which represent about 4% of global supplies in 2017-2019, seem unlikely to change whether a uranium project proceeds as the other market forces and expectations will have significant influence on these longer-term decisions.

5. *Long-term viability and health of the industry*

ERI reports that five new production centers began operation since 2009: two in 2010, one in 2013, one in 2014, and one in 2015. 2017 ERI Report, 67.

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 190 million pounds annually by 2025. ERI attributes this increase in global requirements to an expansion of nuclear generation in China, India and South Korea, as well as new nuclear power entrants. While global demand for uranium is expected to increase, projected U.S. requirements will remain generally steady. 2017 ERI Report, 18-19. Overall, ERI's Reference Forecast for total world nuclear power generation capacity is consistent with a steady average annual nuclear capacity growth rate of 2% through 2035. A 9% decline is projected in the U.S. by 2035, with a 30% decline in Western Europe. 2017 ERI Report, 7. ERI notes that its Reference Forecast for nuclear fuel requirements in its 2017 Report is lower than its Reference Forecast in its 2015 Report due to assumptions of a slower pace of restart of Japanese reactors and the announced and projected premature closing of nuclear power plants in the U.S. and Western Europe. A reduction in nuclear power in France and slower than previously projected growth of nuclear power in Russia contribute to the lesser increase in nuclear capacity growth between 2020 and 2026. 2017 ERI Report, 4-5.

There are a number of important market factors that have influenced the relationship between supply and demand (hence price) since DOE inventory transfers began. These other factors include: demand losses due to the Japanese reactor shutdowns following the Fukushima Daiichi accident, demand losses due to changes in German energy policy, increased uranium production in Kazakhstan, increased secondary supply created using excess enrichment capacity (both underfeeding and upgrade of Russian enrichment tails), the planned ramp-up of Russian uranium under the Suspension Agreement, and the end of the U.S. Russian HEU Agreement in 2013. The effect of DOE inventory can be considered in the broader context of other market factors. ERI notes that DOE inventory was equivalent to about 6% of all the uranium market factors (including DOE) in 2012, rising to 9% in 2013-2014 before declining back to 7% in 2016. ERI predicts that the total of all the non-DOE uranium market factors is expected to remain fairly constant over the next decade as the slow increase in Japanese reactor restarts is offset by additional retirements in Germany. The Base Scenario DOE share remains in the 7%-8% range with the exception of 2020 and 2021 when it drops to 5% and 1%, respectively. If Scenario 1 DOE inventory is assumed, the DOE share declines to just 1% over the next decade. Scenario 2 averages 6% while Scenario 3 averages 8% in 2017-2026. 2017 ERI Report 100-101.

The TradeTech Report in the UPA RFI comments cites many of the same market factors which ERI has accounted for, including persistent oversupply in the uranium market and reduced demand as a result of premature plant closures, as well as the DOE supplied uranium.

Several commenters in response to the July 2016 RFI predict a recovery in either spot or term uranium prices. Cameco, in its comment, states that while "the long-term future of the uranium industry is strong, the market remains oversupplied due in part to the slow pace at which Japanese reactors have come back on line since the Fukushima accident and the closure of a number of U.S. reactors." RFI Comment of Cameco, at 1.

DOE recognizes that, as with any prediction, the future course of events may differ from forecasts. However, as explained in this analysis as well as in the 2015 Secretarial Determination and Analysis, 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.[40]

Alternately, forecasts of production may be somewhat more uncertain. DOE draws similar conclusions in this Determination as in 2015: in aggregate, overall forecasts of aggregate supply are appropriate predictions of the likeliest course of events, and the various sources DOE has consulted offer similar forecasts, and DOE concludes it is appropriate to rely on them.

Commenters note that DOE transfers have affected and will affect the industry in other ways. ConverDyn stated that uncertainty related to DOE uranium transfers adds to the difficult conditions currently facing the industry. RFI Comment of ConverDyn, Enclosure 1, at 2. Energy Fuels Resources (Energy Fuels), in its comment, hypothesizes that the value of domestic uranium mines and projects has diminished due to declining uranium prices since 2011 and an oversupplied market. RFI comment of Comment of Energy Fuels, at 2. Energy Fuels notes that "persistent oversupply from price insensitive sources and limited uncommitted demand." RFI Comment of Energy Fuels, at 3. This view is reiterated in RFI comments by the New Mexico Mining Association, noting that "DOE's material effectively consumes any available uncommitted demand available to (potential New Mexico) producers." RFI Comment of New Mexico Mining Association, at 1.

Additionally, a number of commenters have pointed out that excess inventory needs to be absorbed before a market recovery can occur. Commenters point to EIA data showing an increase in U.S. utility inventory. Energy Fuels and the Uranium Producers of America state that, "the excess supply is absorbed primarily by the trading community that then finances the material for forward sales. As a result, this delays the prospects for a price recovery by "stealing" future uncommitted demand that would otherwise be available in upcoming years." RFI Comment of Energy Fuels, at 5; RFI Comment of UPA, at 7.

Energy Fuels also remarks, "[a]s more reactors go offline and higher priced long-term pre-Fukushima legacy contracts expire, along with DOE material continuing to enter the market, conditions will continue to deteriorate for the production industry." Comment of Energy Fuels, at 5. Additional commenters shared this view. FBP commented that U.S. producers are "far less

[40] DOE notes that even though the 2015 Secretarial Determination and Analysis described an expected price recovery predicted by various market forecasts, uranium prices have decreased since May 2015. Despite that decrease, it is notable that those same market forecasts continue to forecast an increase in price, although they have adjusted the expected timeline for such a recovery. As emphasized in the 2015 Determination and Analysis, this is to be expected given the uncertainty of future market predictions, especially in the short-term. Nevertheless, DOE continues to believe that over the long-term, the rough course of future supply can be predicted with a reasonable degree of certainty.

competitive than available non-U.S. supply" and that non-U.S. producers are better poised to meet any increase in demand because they can provide material at production costs that are below those of U.S. producers. RFI Comment of FBP, at 5. UxC's Uranium Production Cost Study supports the view that [redacted].

Regarding supply, FBP notes the increase in global production since 2007, despite falling prices and reduced reactor demand. RFI Comment of FBP, at 5. "The failure of primary supply to reduce production to match needs is encouraged by long-term contracts at higher than current spot market prices and the significant supply controlled by Sovereign governments." Citing the NAC International Fuel–Trac data base, FBP notes that "it is estimated that around 60% of the 2016 production was controlled by Governments," and suggests that, "[d]ue to the large excess worldwide production increases, neither spot market prices, nor U.S. production competitiveness are expected to improve appreciably in the near-term." RFI Comment of FBP, at 8. DOE notes that the largest producer in the world – Kazakhstan – has indicated that it will reduce production by 10% in the coming years. This will help bring supply and demand into balance sooner than if they had continues to produce at prior levels. FBP also suggests that exchange rates have affected competitiveness resulting in lower effective production costs for non-U.S. suppliers. RFI Comment of FBP, at 10. [redacted] UxC in their Uranium Market Outlook, Q1 2016, 6 and Uranium Production Cost Study, 107-108.

The Wyoming Mining Association suggests that the Department consider drilling as a "harbinger metric for the uranium recovery industry's maintenance and growth." RFI Comment of Wyoming Mining Association, at 2. EIA reports that the number of holes drilled for exploration and development in the U.S. in 2015 was 1,218, down from 11,082 in 2012 and 5,244 in 2013, declines of 86% and 71%, respectively. Similarly, EIA reports 878 thousand feet drilled in 2015, down from 7,156 thousand feet in 2012 and 3, 845 thousand feet drilled in 2013, declines of 88% and 77%, respectively. EIA, 2015 Domestic Uranium Production Report (2016), at 3. UxC points out that during periods of sustained low prices, development is discouraged and higher price mines may be forced to close. [redacted]. UxC Uranium Market Outlook, Q1 2016, 6.

Even if existing production centers continued producing uranium at their current rates, prices could be expected to increase as requirements 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.

Based on the incremental impact of DOE EM transfers on price, and the predicted future increases in price, these DOE EM transfers will not prevent new facilities from coming online, but could potentially affect the timing of such supply additions. DOE does not believe that this impact is significant enough to appreciably affect the long-term viability and health of the industry.

FBP, in its NIPC comments at 3 noted that FBP's subcontractor Traxys has sold DOE-FBP-Traxys material to a Wyoming uranium production who is using the purchased material to deliver on high-priced contracts. FBP notes that "this support was a direct result of the U.S. miners calling upon the Department and FBP to make DOE uranium available to U.S. producers that they could then deliver into their long-term contracts." FBP notes that this offset foreign imports and that Traxys has extend this offer to other U.S. producers as well. Thus the bartered material, in some cases helps support U.S. industry. FBP NIPC comment, 3.

In addition, some NIPC commenters stated that the uranium market remains oversupplied due to a number of factors. Those factors include the slow pace of return of Japanese reactors after the Fukushima accident, early permanent shutdown of a number of existing U.S. reactors and delayed construction of new U.S. reactors. While UPA noted that this oversupply is an unhealthy situation threatening the long-term viability of the domestic market Cameco stated that they believe that the long-term future of the uranium industry is strong. NIPC Comment of UPA, at 16. DOE believes the world-wide construction of new reactors, return of many of the Japanese reactors and construction of new reactors in the United States will be positive for the uranium market and that the long term viability 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, Techsnabexport (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_8in 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.

The current iteration of the Suspension Agreement, described above in Section I.D.3.ii, 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). As mentioned above, in September 2016, the Department of Commerce proposed to adjust the export limits under the agreement to take account of changes in projected reactor demand. The proposed adjusted limits would allow an additional 429,000 pounds U3O8 from Russia into the United States between 2016 and 2020. The additional amount varies by year, but on average, the proposed limits are 6.6% higher than current limits.

Material imported from Russia in accordance with the Suspension Agreement is derived from primary production rather than from down-blended HEU. The 2017 ERI Report takes account of uranium entering the United States under the current Suspension Agreement limits as part of total worldwide primary supply. The 2017 ERI Report does not consider the effect of the additional amount that would be allowed into the United States were the Department of Commerce to adopt the adjusted limits as proposed.

DOE believes that it is still appropriate to rely on ERI's analysis without adjusting for the proposed changes to the Suspension Agreement quota limits. As an initial matter, it bears emphasis that the volume of the proposed adjustment is small relative to the current limits under the Suspension Agreement, to United States requirements, and worldwide requirements. Nominally, the adjustment adds no more than 180,000 pounds U_3O_8 in any given year. Further, it is not clear that Russia would increase production of uranium concentrates to take advantage of this additional quota. Even without the change to the Suspension Agreement, Russia is still free to seek buyers for its uranium in other countries. More important, there is reason to believe that Russian suppliers would not take full advantage of the adjusted quota with respect to natural uranium. DOE understands that a significant portion of Russian uranium entering the United States under the agreement enters via SWU-only contracts.[41] Unlike EUP, which contain the Russian uranium component, SWU-only imports do not. This is because the purchaser would be required under the contract to deliver to the seller an amount of natural uranium equivalent to that contained in the enriched uranium. That natural uranium would need to be purchased on the open market, i.e. from non-Russian sources.

For these reasons, DOE's analysis takes sales of uranium under the Suspension Agreement into account as part of overall supply available in the market, and the proposed adjustments are small enough that even if they are adopted, the adjusted figures would not significantly alter DOE's analysis.

7. *Mining industry conclusion*

After considering the factors discussed above, DOE concludes that transfers under either the Base Scenario, which represents the current rate of EM transfers, or the lower transfer rate of 1,200 MTU per year beginning in May 2017 will not have an adverse material impact on the domestic uranium mining industry. As explained above, DOE transfers under the Base Scenario will continue to exert some downward pressure on the market price for uranium concentrates. However, the forecasted price effect of $1.40 per pound U_3O_8 reasonably attributable to DOE transfers is somewhat smaller than the effect attributable to transfers in the past few years. DOE believes that transfers at the lower rate will have a slightly lower effect on market prices.

Because the 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 and because essentially all U.S. producers have at least partially hedged from the spot price, DOE concludes that the average effect on the realized price of U.S. producers under current contracts is less than that amount. For future term contracts, price suppression associated with DOE transfers would decrease the base price of future long-term 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 the impact of the transfers under either scenario is small and within the range of normal market fluctuations.

[41] Taking information from the ERI Report on the proportion of material supplied under the Suspension Agreement in the form of EUP sales, DOE assumes at least 20% of material going to SWU-only contracts. 2017 ERI Report, 102.

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 as protected from fluctuations in the spot price—it is not likely that removing the price effect attributable to DOE transfers 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).

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. MTW and ConverDyn may be referred to interchangeably, because the two appear to have essentially the same interests in uranium markets.

1. *Prices for conversion services*

Prices in the conversion markets are generally described in terms of spot and term price, like the uranium concentrates market. The following discusses the potential impact of DOE transfers on these two prices. For reference, as of April 17, 2017, UxC spot price indicator was $5.85 per kgU as UF_6, and the [redacted].[42] DOE obtained information about conversion services prices from Energy Resources International. In its NIPC comment, ConverDyn shared that conversion services spot prices are 30% lower and long-term prices 22% lower than compared with the prices used in the 2015 Secretarial Determination. NIPC Comment of ConverDyn at 1.

i. Energy Resources International Report

In the 2017 ERI Report, like the 2015 ERI Report, ERI estimated the effect of DOE transfers on the market prices for conversion services using a market clearing price methodology. As with the uranium concentrates, ERI conducted the clearing prices analysis on both an annual and cumulative basis, constructing individual supply and demand curves for conversion services and estimating the clearing price with and without DOE transfers. 2017 ERI Report, 44. ERI's clearing price effect on conversion services represents a change in the market-clearing price for spot prices. The same DOE transfer scenarios described in Section IV.A.1 were used in the analysis.

[42] UxC, UX WEEKLY, April 17, 2017 (Volume, 31, Number 16) at 1.

Like the uranium concentrates analysis, we first present the estimates of the price impacts in the market clearing models using the two different supply side approaches. It is important to emphasize that, under either approach, these numbers do not constitute a prediction that prices will decrease by the specified amounts following DOE transfers under a new determination and, further, that the impact of prior transfers is already taken into account by the market in the current spot prices.

To gain additional perspective, we then assess the impact of future DOE transfers under the cumulative methodology based on the difference in market clearing price in any given year between a scenario with zero EM releases of uranium (scenario 1) compared to the scenarios where EM uranium is released at different rates.

Using the market clearing price model, on an annual and cumulative basis, ERI estimates that DOE transfers will have the price effects on the conversion services industry listed in Tables 7 and 8, respectively.

	ERI Scenario 1 – No EM Transfers	**ERI Base Scenario Current Level (1,600 MTU/year)**	**ERI Scenario 2 Lower Level (1,200 MTU/year)**	**ERI Scenario 3 Higher Level (2,000 MTU/year)**
2017	$0.10	$0.40	$0.30	$0.40
2018	$0.00	$0.10	$0.10	$0.10
2019	$0.20	$0.60	$0.50	$0.50
2020	$0.20	$0.30	$0.40	$0.20
2021	$0.00	$0.00	$0.10	$0.00
2022	$0.10	$0.10	$0.10	$0.10
2023	$0.10	$0.10	$0.10	$0.10
2024	$0.40	$0.40	$0.40	$0.40
2025	$0.50	$0.50	$0.50	$0.50
2026	$0.50	$0.50	$0.50	$0.50
Average (2017 – 2026)	$0.20	$0.30	$0.30	$0.30

Table 7. ERI's Estimate of Effect of DOE Transfers on Conversion Prices in $ per kgU as UF_6 (Annual Market Clearing Approach)

	ERI Scenario 1 – No EM Transfers	ERI Base Scenario Current Level (1,600 MTU/year)	ERI Scenario 2 Lower Level (1,200 MTU/year)	ERI Scenario 3 Higher Level (2,000 MTU/year)
2017	$0.90	$1.10	$1.10	$1.10
2018	$1.10	$1.10	$1.10	$1.20
2019	$1.60	$2.30	$2.10	$2.30
2020	$1.50	$1.90	$1.90	$1.80
2021	$0.10	$0.70	$0.80	$0.70
2022	$0.20	$0.20	$0.20	$0.20
2023	$0.10	$0.10	$0.10	$0.10
2024	$0.40	$0.40	$0.40	$0.40
2025	$0.50	$0.50	$0.50	$0.50
2026	$0.50	$0.50	$0.50	$0.50
Average (2017-2026)	$0.70	$0.70	$0.90	$0.90

Table 8. ERI's Estimate of Effect of DOE Transfers on Conversion Prices in $ per kgU as UF_6 (Cumulative Market Clearing Approach)

We next determine the marginal price effect under the cumulative methodology. For the same reasons described in Section IV.A.1, the impact of future DOE transfers is best understood and expressed as the marginal or incremental difference between zero EM transfers compared to scenarios with EM transfers. Scenario 1 serves as the point of reference for the analysis of price effects from the other scenarios of DOE releases because it includes the price effects from prior DOE uranium inventory releases plus an increment for the NNSA transfers but no EM transfers.

Table 9 provides the price effects estimated by ERI for the varied scenarios of EM transfers under the cumulative method expressed as the marginal price effect.

	ERI Scenario 1 – No EM Transfers	ERI Base Scenario Current Level (1,600 MTU/year)	ERI Scenario 2 Lower Level (1,200 MTU/year)	ERI Scenario 3 Higher Level (2,000 MTU/year)
2017	$0.00	$0.20	$0.20	$0.20
2018	$0.00	$0.00	$0.00	$0.10
2019	$0.00	$0.70	$0.50	$0.70
2020	$0.00	$0.40	$0.40	$0.30
2021	$0.00	$0.60	$0.70	$0.60
2022	$0.00	$0.00	$0.00	$0.00
2023	$0.00	$0.00	$0.00	$0.00
2024	$0.00	$0.00	$0.00	$0.00
2025	$0.00	$0.00	$0.00	$0.00
2026	$0.00	$0.00	$0.00	$0.00
Average (2017 – 2026)	$0.00	$0.20	$0.20	$0.20

Table 9. Marginal Price Effect of Varied Rates of DOE Transfers on Conversion Prices in $ per kgU as UF_6 – Cumulative Method

Table 9 illustrates that, for example, the price effect attributable to DOE transfers under the Base Scenario in 2017 would be $0.20, the difference between the cumulative price effect under the Base Scenario ($0.30) and the cumulative price effect under Scenario 1 ($0.10). In other words, prices would be suppressed by the marginal or incremental amount of $0.20 if DOE pursues the EM transfers under the Base Scenario, not $0.30, as the current price already includes the price suppression of $0.10 (Scenario 1 point estimate price) from previous DOE releases.

ERI also presented information on the cumulative clearing price effect relative to "No DOE" clearing price for uranium, where the "No DOE" clearing price assumes that DOE releases from 2009 onward were zero. 2017 ERI Report, 60. Table 4.8 in the ERI Report provides assessment of price impacts going forward, for the period 2017 to 2026, and the estimated change in the conversion clearing price attributable to the DOE inventories under the four scenarios relative to the "No DOE" market prices. The cumulative percentage change in prices noted in ERI's Table 4.8 also can be expressed as a marginal effect to better represent how future EM inventory releases would affect prices.

Table 10 presents the marginal price effect expressed as a percentage of market price.

	ERI Base Scenario Current Level (1,600 MTU/year) Marginal %	ERI Scenario 2 Lower Level (1,200 MTU/year) Marginal %	ERI Scenario 3 Higher Level (2,000 MTU/year) Marginal %
2017	2%	2%	3%
2018	1%	1%	2%
2019	5%	4%	5%
2020	3%	3%	2%
2021	5%	5%	5%
2022	0%	0%	0%
2023	0%	0%	0%
2024	01%	0%	0%
2025	0%	0%	0%
2026	0%	0%	0%
Average (2017 – 2026)	3%	3%	3%

Table 10. Cumulative Marginal Price Effects as Percentage of "No DOE" Clearing Price

For example, under Scenario 1, where EM transfers are halted starting in 2017, average conversion prices for the period 2017-2016 would be 3% higher (7% - 4%) than under Scenario 1. Stated otherwise, the percentage price effect for each scenario other than Scenario 1 is the difference between the cumulative percentage for the Scenario in question and the cumulative percentage change for Scenario 1. E.g., in year 2020, under the Base Scenario prices would be 3% (15% - 12%) higher than under Scenario 1.

As with uranium concentrate pricing, DOE has considered the 2017 ERI Report and ERI's explanation of its market clearing price methodology with respect to the conversion market. With respect to the spot market, DOE's conclusions regarding ERI's methodology apply equally to conversion as they do to uranium concentrates. However, for the reasons explained in the 2015 Secretarial Determination and Analysis, DOE believes that the clearing price model will greatly overestimate the effect of DOE transfers on the conversion *term* price. In essence, ERI's market clearing approach—either annual or cumulative—assumes that the conversion price arises from a competitive market price-setting mechanism. This does appear to be the case for the spot market, which has a large number of suppliers and appears to quickly respond to changes in supply in demand. The term price, however, does not appear to arise from a competitive price-setting mechanism. Certain aspects of the conversion services market lend support to this conclusion. For one, the term conversion market is highly concentrated and consists of a very small number of primary suppliers. Highly concentrated markets such as these may be susceptible to parallel pricing such that pricing decisions may be unresponsive to changes in supply and demand. In addition, demand for nuclear fuel is relatively inelastic in the mid-term—this is particularly true for conversion services given that conversion makes up a smaller proportion of the price of enriched uranium product than enrichment or uranium concentrates. 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.

This is consistent with how the conversion term price has reacted in recent years to changes in supply in demand. The 2015 Secretarial Determination and Analysis described the response of the conversion term price to market changes prior to 2015. Since then, although the conversion term price has fallen, it still remains at more than twice the current spot price. Furthermore, there is reason to believe that the recent decline in conversion term price does not necessarily reflect a decrease in the price that primary converters are able to command for long-term contracts. As reported by UxC, [redacted] UxC Conversion Market Outlook at 33. [redacted] Id. at 32. [redacted] Id. at 51. This supports the notion that utilities have been willing to accept and commit to higher prices than a competitive price mechanism would produce. For these reasons, although ERI's market clearing approach provides a reasonable estimate of the effect of DOE transfers on the conversion spot price, it likely significantly overstates the effect on the conversion term price.

ii. Effect of DOE transfers on market prices

Based on the foregoing discussion of market analyses and DOE's consideration of the different methodologies, DOE concludes that pursuing the level of transfers under the Base Scenario will suppress the spot market price of uranium conversion on average in the next decade in either $0.20 or $0.30 per kgU, based on the marginal cumulative clearing price approach and the annual clearing price approach, respectively. After analyzing all of the estimates available, DOE bases its conclusions here on the largest possible price effect of the transfers in any given year, in this case the annual market-clearing price effect of $0.30 per kgU. This estimate is approximately the same as the average price effect for the near-term - from 2017 through 2019 – of $0.30 (cumulative) or $0.36 (annual) per kgU. Further, DOE transfers will be conducted at rates even lower than the Base Scenario, closer in effect to those posited in Scenario 2, creating a positive effect on market prices of roughly $0.10 in 2017 as compared to the Base Scenario, the difference between the Base Scenario price effect ($0.40) and Scenario 2 price effect ($0.30) under the annual method. DOE further concludes that its transfers will have essentially no effect on the term price for conversion.

Similar to uranium concentrates, the significance of price suppression at this level depends, in part, on current and forecasted market prices. UxC's Nuclear Fuel Price Indicators, showed $5.85 per kgU as the spot market price at the end of March 2017. The forecast price effect reasonably attributable to DOE transfers ($0.30 per kgU) represents about 5% of these current market values. This result is more conservative than that shown in Table 10, which reflects in 2017 only a 2% marginal cumulative price effect for DOE transfers in the Base Scenario under the "No DOE" clearing price approach. However, in any case, most conversion is sold under long-term contracts not using spot prices, and the sole domestic converter makes most of its sales that way.

Moreover, the price effect of $0.30 is within the range of market fluctuations experienced in the conversion industry in recent years. As previously noted, ERI's statistical model of price volatility on an annualized basis (as shown in 2017 ERI Report, Figures 4.34 and 4.35) illustrates the conclusion that historical price volatility is noticeably higher for the uranium and conversion markets than for the enrichment market over the long term, although enrichment term price volatility has been higher and conversion term price volatility has been lower, relatively, in the last two years. 2017 ERI Report, 94-96. For example, the spot prices of conversion from January 2015 to December 31, 2016 declined by 30%, and from December 31, 2016 to the March 2017, declined by 2.5%. For term prices, the change from January 2015 to December 31, 2016 was 19%. Price effects that are about 5% are not substantial or outside historical experience in the conversion markets.

It is also appropriate to compare the price effect in future years to forecasted market prices in those years. Using near-term projected spot market prices from UxC's Conversion Market Outlook – Dec 2016, at 78, [redacted], DOE calculates that the average price effect of planned DOE transfers under the Base Scenario assuming a price effect of $0.30 per kgU would cause an average percent decrease in the near-term of 5% per year. Looking at UxC's 10-year average price projections yields a [redacted] price change. While ERI's market-clearing price effect is not intended to be a direct price forecasting tool, using the ERI Reference Case price forecasting data allows us to derive an approximate percentage future effect. This is also in line with the average percentage cumulative marginal effect calculated based on ERI's projected percentage changes.

iii. Effect on realized prices

A principal mechanism through which a change in market price could impact the domestic conversion industry is through the effect on the prices that they actually receive for the uranium they sell – the "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. ERI projects that global uranium conversion services requirements will average 58.7 million kgU/year between 2017 and 2019. U.S. requirements are expected to average about 17.2 million kgU in the same timeframe. 2017 ERI Report, 84. Based on transfers at the Base Scenario level, ERI projects that DOE transfers will constitute approximately 4% of the global requirements for conversion services in 2017-2019. 2017 ERI Report, 43.

No commenter provided 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. As stated above, DOE understands that the conversion market generally relies on mid- and long-term contracts. UxC Conversion Market Outlook – December 2016, 30-31 [redacted]

[43] UxC Conversion Market Outlook, December 2016, 68.

[redacted]. Id. at 33. [redacted] Id. at 29. [redacted] Id. at 29.[46] Assuming this spot contracting activity was divided proportionately by production among the Western converters based on UxC's estimated production levels over that time period, ConverDyn's share would have been roughly 1,000,000 kgU spread out over three years.[47] If trends continue at this rough rate, DOE conservatively estimates that ConverDyn's exposure to the spot market price could be no more than 350,000 kgU per year, or less than 4% of estimated production over that period.[48]

To the extent that ConverDyn engages in spot sales, they represent no more than 4% of its total sales, and likely represent significantly less. Considering this in combination with ConverDyn's past statements about its contracting practices, namely that ConverDyn's long-term contracts are priced at the prevailing term price (with some escalation for inflation), and that [redacted] DOE concludes that ConverDyn has virtually no exposure to the spot price.

As explained above, the Department concludes that the term price will remain relatively stable despite DOE's transfers. Therefore, DOE concludes that planned uranium transfers under the Base Scenario will not appreciably affect ConverDyn's realized price for its services.

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44 UxC Conversion Market Outlook, December 2016, 51.

45 UxC Conversion Market Outlook, December 2016, 71.

46 [redacted]. Id. at 29.

47 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, and AREVA's Comurhex facility in France. There is also a very small conversion facility in Sao Paulo, Brazil, with a capacity of approximately 100,000 kgU as UF_6.

48 DOE believes this is a conservative estimate for several reasons. First, as mentioned above, the primary converters have been a significant *purchaser* in the spot market in recent years; in fact, [redacted]. Second, 2016 spot contracting activity was lower than in previous years, a trend that may continue into 2017 and 2018. Third, it appears that not all spot contracting for conversion in 2015 and 2016 were filled by primary supply, even when the seller was a primary converter. [redacted] Id. at 29

2. *Production at existing facilities*

There is only one existing conversion facility in the United States, the Metropolis Works facility (MTW) in Metropolis, Illinois, operated by Honeywell International. ConverDyn is the exclusive marketing agent for conversion services from this facility. RFI Comment of ConverDyn, at 1; 2015 ERI Report, 64. This section focuses on the potential effects of DOE transfers on production at MTW, including the impact on sales volumes and changes in average production costs.

ERI estimated the effect of DOE transfers on production at MTW based on a series of assumptions about ConverDyn's production volume and market share derived in part from various statements from ConverDyn.[49] Based on publicly available information, including a declaration presented by ConverDyn in support of litigation against DOE, DOE's 2015 Secretarial Determination and Analysis, and an estimate by another converter, ERI estimates that ConverDyn's annual production volume is 10 million kgU. 2017 ERI Report, 81.

In estimating the effect of DOE transfers on ConverDyn's sales volume, ERI assumes that 50% of the material EM transfers in exchange for cleanup services and 100% of all other DOE material enters the U.S. market. 2017 ERI Report, 82. Based on statements from ConverDyn, ERI assumes that ConverDyn's current share of the U.S. market for conversion services is 25% and that its share of the international market is 24%. 2017 ERI Report, 86.

ERI also estimates the effect of DOE transfers on ConverDyn's production costs. To calculate this effect, ERI assumes that ConverDyn's production cost would be $15 per kgU if DOE material was not being introduced into the market. ERI further assumes that 80% of Metropolis Works' costs are fixed. ERI then applies these assumptions to its estimate, described above, of the effect of DOE transfers on ConverDyn's sales volume. The reasoning being, if MTW produced additional conversion in the quantities estimated, the 80% fixed cost would be spread over a greater sales volume, and only 20% of the costs would scale to match production.

A summary of ERI's estimates of the effect of DOE transfers on ConverDyn's sales volume and production costs appears in Table 11. Applying ConverDyn's U.S. market share of 25% and the remaining world market share of 24% to the volume of DOE inventory expected to be introduced into the market in 2018, results in a volume effect of 0.4 million kgU in the U.S. market and 0.2 million kgU effect in the remaining world market for a total of 0.6 million kgU, under the Base Scenario, for an increase in production costs of 5%.

In Scenario 1, in which UF_6 associated with prior releases of DUF_6 to ENW enter the market, the introduction of DOE inventory results in a decreased volume of 0.6 million kgU and increased production costs of 1%. The introduction of DOE inventory into the conversion market results in a

[49] 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.

decreased volume of 0.5 million kgU and increased production costs of 4% in Scenario 2 and a decreased volume of 0.7 million kgU and increased production costs of 5% in Scenario 3. 2017 ERI Report, 85-89.

As with ERI's price estimates discussed above, these estimates do not suggest that were DOE to transfer uranium in accordance with the Base Scenario, ConverDyn would lose the predicted volume of sales or that its production cost would increase. DOE has been transferring at or above the rate of the Base Scenario for nearly three years, and therefore these effects—or a similar level of effect—are currently being experienced by MTW due to transfers in prior years. Continued transfers at the Base Scenario rate would only continue these effects at the estimated levels.

	Estimated Change in ConverDyn Volume (million kgU)	Production Cost Increase (Percent Change)
Base Scenario	0.6	5.0%
Scenario 1	0.2	1.0%
Scenario 2	0.5	4%
Scenario 3	0.7	5%

Table 11. ERI's Estimate of Impact of DOE Transfers on ConverDyn's Sales Volume and Estimated Production Cost Increase

DOE believes that ERI's approach to estimating lost sales volume based on market share is reasonable. DOE also believes that ERI's approach to estimating the change in average per unit production costs that volume decrease 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.

That said, DOE has other available information that suggest that certain of ERI's assumptions may be outdated. To account for this information, DOE has developed its own estimate for sales volume loss and change in production cost based on ERI's methodology but utilizing the slightly different assumptions described below.

ERI bases its estimate of MTW production levels at least in part on DOE's 2015 Secretarial Determination and Analysis. DOE has revisited and updated this information. In 2015, DOE relied on UxC's Conversion Market Outlook, [redacted] UxC's most recent Conversion Market Outlook estimates [redacted] . [redacted] UxC, Conversion Market Outlook, Dec. 2016, at 44. In addition, ConverDyn states in its comment in response to the NIPC that it has halved its production capacity. ConverDyn NIPC Comment, at 1. Honeywell's website similarly notes that "Honeywell plans to reduce the production capacity of the Metropolis plant to better align with the demands of nuclear fuel customers."[50] ConverDyn does not state the numerical capacity of MTW after the announced production capacity reduction. However, another commenter refers to an announcement from Honeywell that the nameplate production capacity of MTW—previously reported at 15 million kgU—will be permanently reduced to 7 million kgU through "physical changes to the conversion plant as well as through workforce reductions." FBP at 3. Other sources have also reported the reduction in MTW's capacity to 7 million kgU.[51] Given that this capacity reduction has been reported in multiple sources, DOE believes it is likely to be an accurate reflection of the upper bound of MTW capacity in the coming years.

Therefore, DOE has applied ERI's approach to estimating reduction in sales volume and production costs with the assumption that MTW capacity has a maximum of 7 million kgU. Using this figure, MTW can be expected to experience a reduction in sales volume of about 400,000 kgU in 2017, 500,000 kgU in 2018, and 600,000 kgU in 2019.[52] Using ERI's assumptions about fixed cost to variable cost ratio and ConverDyn's total production cost with DOE transfers, production costs would be expected to be higher by $0.80 on average between 2017 and 2019.

In addition, ConverDyn's comment in response to the RFI includes an enclosure with an estimate of its domestic cost of production for conversion services. ConverDyn RFI comment, Encl. 2. ConverDyn explains [redacted] Id. Altering this assumption in the above calculations would have a very minor effect on the estimates described above, regardless of which production level is assumed.[53] Therefore, DOE believes it is reasonable to rely on the estimate described above that DOE transfers will affect ConverDyn's marginal production cost by roughly $0.80 between 2017 and 2019.

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 [redacted][54] Based on available information, it appears that MTW capacity may be permanently limited to an annual production of 7 million kgU, a figure that is less than half of MTW's previously reported nameplate capacity. DOE notes that the predicted decrease in volume reasonably attributable to DOE under either set of

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[50] *Statement from Honeywell*, http://www.honeywell-metropolisworks.com/ (accessed Apr. 13, 2017).

[51] UxC has noted the reduction in capacity in a recent weekly report, UxC Weekly, April 10, 2017, at 3, and the World Nuclear Association has adjusted its world capacity information to reflect the decrease in capacity. http://www.world-nuclear.org/information-library/nuclear-fuel-cycle/conversion-enrichment-and-fabrication/conversion-and-deconversion.aspx (accessed Apr. 13, 2017).

[52] DOE notes that ConverDyn has maintained that its capacity reduction is permanent. If this is true and ConverDyn is producing at or close to its maximum capacity, ConverDyn would not be able to increase primary production within a short period of time to absorb additional production volume. Nevertheless, DOE will assume for the sake of this analysis that ConverDyn could increase production to account for the additional sales volume.

[53] In at least one of the calculations, the change is not evident after the estimated change in production cost is rounded to the nearest $0.10.

[54] UxC Conversion Market Outlook, December 2016, 44.

assumptions—about 600,000 kgU based on ERI's assumptions and as low as 400,000 kgU if MTW capacity is limited to 7 million kgU—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 7 times the magnitude of the sales volume decreases attributable to DOE. Given that ConverDyn has a significant proportion of fixed costs, these swings in production would be expected to alter ConverDyn's marginal production cost in a similar manner. Thus, the expected change in production cost—$0.80—is also well within the range of fluctuations experienced at MTW in recent years.

3. *Employment levels in the industry*

ERI assumes in its analysis a staffing level of 242 employees in 2017[55] for a production level of 10 million kgU. Previously, as in 2015, ERI had estimated that Metropolis Works staffing would remain at 270 employees, with an annual production rate of 10 million kgU. In the 2015 Report, ERI noted that Metropolis Works restarted after an extended shutdown in summer 2013 with approximately 270 employees, which was a decrease from the previous employment of 334 people. 2015 ERI Report, 72–73; 2014 ERI Report, 71. Information on the Honeywell/Metropolis Works website[56] indicates that the plant employs 250 full-time employees. In January 2017, Honeywell announced a workforce reduction: "Due to the significant challenges of the nuclear industry globally and the oversupply of uranium hexafluoride (UF_6), Honeywell plans to reduce the production capacity of the Metropolis plant to better align with the demands of nuclear fuel customers. Because of this, the company intends to reduce its full-time workforce by 22 positions, as well as a portion of the plant's contractor team. We are taking this action to better position the plant moving forward."[57] In its NIPC comments, ConverDyn noted that it has eliminated 87 positons since the last Secretarial Determination. NIPC Comment of ConverDyn at 1.

ERI makes estimates regarding the impact of DOE uranium transfers on employment using the assumption that staffing is proportional to production rate but notes the limitations of such estimates. ERI suggests that it is unlikely that staffing is directly proportional to production volume, thus characterizes their assessment as conservative. 2017 ERI Report, 90.

Based on ERI's assumed staffing level of 242 FTE and a production of 10 million kgU, assuming that staffing is proportional to production, then for every 100,000 kgU reduction in annual production, there would be a 2.4 FTE loss in staff. Under the Base Scenario, ERI attributes a 0.6 million kgU reduction in production volume to DOE sales, which results in a 14 FTE loss. This compares to a 0.2 million reduction in production volume attributable to DOE sales with no EM uranium transfers, which would result in a 5 FTE loss. Therefore, the impact on employment would be the difference between the impact under the Base Scenario and the impact under Scenario 1, with no EM transfers, or 9 FTE (14 FTE -5 FTE).

A reduction in employment of 9 person-years is relatively small, particularly in comparison to MTW's reduction of approximately 64 after the 2012-2013 shutdown, and the 87 FTEs that

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55 ERI arrives at the 242 full-time employee (FTE) using information from press reports of staffing levels prior to the January 2017 reduction. 2017 ERI Report, 90.

56 http://www.honeywell-metropolisworks.com/ (accessed April 13, 2017).

57 http://www.honeywell-metropolisworks.com/message-from-the-plant-manager/ (accessed April 13, 2017).

ConverDyn has eliminated since the 2015 Determination. The industry has been able to weather employment losses much larger than any that could reasonably be attributed to DOE transfers. In addition, it is clear that other factors, in addition to production volumes will affect employment levels.

4. *Changes in capital improvement plans and development of future facilities*

Neither ERI nor any of the commenters provide an estimate of the effect of DOE transfers on new facility development or capital improvement plans. While DOE's task is to assess the state of the domestic uranium conversion industry with and without DOE transfers, we believe that activities in the global conversion industry may in some cases be relevant for assessing how DOE transfers will affect the domestic conversion industry.

The Department is aware of limited uranium conversion development projects that are currently planned or underway outside the United States. AREVA's COMURHEX II facilities are under construction with full transition to the new COMURHEX II facility in the 2018-2021 period. In May 2016, Cameco and Kazatomprom announced that they are undertaking a feasibility study for a uranium conversion plant that will convert 6,000 metric tons to U_3O_8 annually. That agreement provides that if the joint refinery is built, Kazatomprom will have the option to obtain UF_6 conversion services at Cameco's Ontario, Canada –based Port Hope conversion facility. [58] ERI also notes that expansion of Chinese conversion capacity is expected to meet indigenous requirements. Finally ERI notes that Russia's Rosatom Siberian Chemical Combine center is expected to add new capacity to come on line in 2019. 2017 ERI Report, 13.

DOE is not aware of any conversion development or expansion plans in the United States. However, press articles report that the Wyoming Business Council is looking at permitting changes that may be needed to allow for the construction of a uranium conversion facility in the State to allow for upgrading of uranium mined in Wyoming before leaving the state. The goal appears to situate Wyoming as a potential uranium conversion site when the market will support another facility.[59]

The Honeywell/Metropolis Web site notes that Honeywell has spent over $177 million in capital improvements over the last 10 years, including $50 million for safety upgrades required by the U.S. Nuclear Regulatory Commission (NRC).[60] In a message from the Metropolis Works Plant manager, the company notes that it intends to invest $10 million per year on projects that directly support health, safety and the environment.[61] ConverDyn has not stated in its Comment in response to the RFI or NIPC whether they have any intentions to make updates and capital improvements to the

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[58] Cameco and Kazatomprom Sign Agreement to Restructure JV Inkai, (2016), https://www.cameco.com/media/news/cameco-and-kazatomprom-sign-agreement-to-restructure-jv-inkai (accessed April 5, 2017).

[59] *Uranium conversion potential for Wyoming, some say*, CASPER STAR TRIBUNE, Oct. 15, 2016, http://trib.com/business/energy/uranium-conversion-potential-for-wyoming-some-say/article_b0f1fb8b-4ad6-5dfd-8358-60b1e69cf2ea.html, (accessed April 5, 2017).

[60] http://www.honeywell-metropolisworks.com/about-us/, (accessed April 5, 2017).

[61] http://www.honeywell-metropolisworks.com/message-from-the-plant-manager/, (accessed April 5, 2017).

Metropolis facility. As mentioned above, Honeywell recently apparently announced that they will permanently reduce capacity to 7 million kgU, this reduction will be at least partially be achieved by workforce reductions. Based on this information, it does not appear that there are any plans to expand capacity at MTW in the near future, but presumably, production could theoretically be ramped up again with additional capital improvements. Honeywell's current NRC operating license for MTW expires in May 2017. In a November 1, 2016 meeting with NRC, Honeywell indicated that it would file an application in January 2017 for a renewal of its license for 40 years.[62] However, UxC in its December 2016 Market Outlook reports that [redacted].[63] It is not clear what capacity Honeywell will seek to relicense. However, with Honeywell's intent to seek a 40-year license renewal, DOE believes that it is likely that even if MTW will not invest in improvements aimed at increasing production capacity, MTW will continue to make capital improvements and refurbishments that are necessary to maintain current capacity for the foreseeable future. As noted earlier, Honeywell has invested a substantial amount in such capital improvements in recent years.

In any case, 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. DOE transfers are expected to decrease ConverDyn's sales volume, but even without EM's transfers, ConverDyn's total sales would still be below MTW's previous maximum nameplate capacity. In addition, transfers under the Base Scenario will represent only about 4% of total global requirements in coming years. DOE concludes that eliminating this amount of conversion would not make a difference to the assessment that new capacity in the United States is not warranted.

5. *Long-term viability and health of the industry*

ERI's November 2016 Reference Nuclear Power Growth forecasts project global requirements for conversion services to grow to approximately 62 million kgU by 2020, approximately 9% higher than current requirements. Global requirements are expected to continue to rise to a level of 80 million kgU by 2032 to 2035, approximately 40% higher than current requirements. 2017 ERI Report, 14.[64] ERI presents a graph comparing global requirements, demand, and supply from 2016–2035. That graph forecasts that global secondary supply and supply from primary converters will continue to exceed global demand until at least 2035. ERI notes that the supply excess will average nearly 13 million kgU as UF_6 annually over the next ten years (2017-2026), which they note is equivalent to 20% of requirements. 2017 ERI Report, 13. ERI projects that global uranium conversion services requirements will average 58.7 million kgU/year between 2017 and 2019. U.S. requirements are expected to average about 17.2 million kgU in the same timeframe. 2017 ERI Report, 84. Under the Base Scenario, DOE inventory represents 4% of world conversion requirements in 2017-2019 and 3% of world conversion requirements in the 2017 to 2026 timeframe. ERI Report, 42. DOE uranium inventories represented 15% of secondary supply

[62] Honeywell Presentation, NRC license discussion (Nov. 1, 2016), https://www.nrc.gov/docs/ML1630/ML16309A092.pdf, (accessed April 5, 2017).

[63] UxC Conversion Market Outlook, December 2016, page 51.

[64] 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.

affecting the global conversion market in 2015 and 2016. 2017 ERI Report, 13. If markets that are deemed not to be accessible to U.S. producers are examined, DOE EM transfers under the Base Scenario represent 6% of accessible world conversion requirements in 2017 to 2019 and 4% of world conversion requirements in the ten years 2017 to 2026. 2017 ERI Report, 43.[65]

In its December 2016 Conversion Market Outlook, UxC predicts that demand is generally expected to increase over the next decade. [redacted]

The above figures include reactor requirements as well as inventory building. Without inventory building, UxC's base demand in 2016 [redacted].[66]

Like ERI, UxC predicts that [redacted][67]

Further UxC notes that [redacted]. UxC says, [redacted]"[68] Separately, UxC reports that [redacted][69] In the longer-term, UxC believes tha [redacted][70]

Given that conversion demand in North America is expected to remain relatively steady, and that UxC predicts [redacted], as well as the indication that Honeywell plans to operate for the long-term as indicted by their announced intent to apply for a 40-year license renewal, it is likely that the domestic uranium conversion industry will retain its capacity, either through continuing

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[65] 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.

[66] Id. at 40.

[67] Id. at 44.

[68] Id. at 68.

[69] Id. at 51.

[70] Id. at 71.

refurbishments at MTW or through the development of one or more new conversion facilities. 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.

Although DOE transfers may not have a large effect on the conversion term price, displaced production volume increases average production costs for primary producers. However, DOE does not believe this effect is significant enough to appreciably affect the long-term viability and health of the domestic uranium conversion 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. 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.ii, 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).

As mentioned above, in September 2016, the U.S. Department of Commerce proposed to adjust the export limits under the agreement to take account of changes in projected reactor demand. The proposed adjusted limits varies by year, but on average, the proposed limits are 6.6% higher than current limits.

Material imported from Russia in accordance with the Suspension Agreement is derived from primary production rather than from down-blended HEU. The 2017 ERI Report takes account of enrichment entering the United States market under the current Suspension Agreement limits as part of total worldwide primary supply. The 2017 ERI Report does not consider the effect of the additional amount that would be allowed into the United States were the Department of Commerce to adopt the adjusted limits as proposed.

DOE believes that it is still appropriate to rely on ERI's analysis without adjusting for the proposed changes to the Suspension Agreement quota limits. It bears emphasis that the volume of the proposed adjustment is small relative to the current limits under the Suspension Agreement, to United States requirements, and worldwide requirements. DOE's analysis already takes into account the amount of conversion services entering the United States from Russia under the current limits, and DOE does not believe that the adjusted limit would significantly alter DOE's analysis even if adopted.

7. *Conversion Industry Conclusion*

After considering the six factors as discussed above, DOE concludes that transfers under either the Base Scenario or the lower rate of 1,200 MTU per year will not have an adverse material impact on the domestic uranium conversion industry. The sole conversion provider in the United States, ConverDyn, continues to sell nearly exclusively on term contracts. Although the move towards more mid-term contracts has affected the term market, it is not clear that this has affected ConverDyn's realized price under its existing or new term contracts. DOE believes that price suppression of $0.30/kgU in the spot market will not be material for the domestic conversion industry.

DOE forecasts that over time, MTW's production will be smaller than it would have been in the absence of DOE transfers by between 400,000 kgU and 600,000 kgU. DOE conservatively estimates such a reduction would increase MTW's average production costs by about $0.80 between 2017 and 2019. The reduced production may also lead to a decrease in employment, which is estimated to be 9 FTE. DOE does not believe these changes would constitute a material impact, within the meaning of section 3112(d), because they are well within the range of fluctuations that MTW has experienced in recent years independent of DOE transfers.

Honeywell, the owner and operator of MTW, continues to invest in maintaining and refurbishing the MTW facility, has indicated that it will be applying for license renewal for a 40-year term and Even taking account of Honeywell's recent announcement to reduce MTW's capacity, DOE transfers are unlikely to appreciably change MTW's capital improvement and refurbishment plans. Furthermore, DOE transfers are unlikely to affect the decision whether to invest in new conversion capacity in the United States.

DOE does not believe that any of the effects described above constitute an impact on the domestic uranium conversion industry of the substantial importance that would rank as "material" within the meaning of section 3112(d).

C. Uranium enrichment industry

The domestic uranium enrichment industry consists of a relatively small number of companies. There is only one currently operating enrichment facility in the United States, the URENCO USA (UUSA) gas centrifuge facility in New Mexico. DOE is also aware of additional planned enrichment facilities in Ohio, and North Carolina. The Paducah Gaseous Diffusion Plant closed in 2013. Centrus, formerly USEC Inc., the former operator of the plant, no longer produces enriched uranium but does sell uranium. The uranium sold by Centrus comes from its inventory, SWU purchased from other suppliers, and SWU purchased under a Transitional Supply Contract with TENEX. 2017 ERI Report, 92. The SWU purchased from Russia can be sold in limited quantities in the U.S., with the rest sold to non-U.S. customers. Id.

According to URENCO's comments in response to the RFI and NIPC, the current capacity of the UUSA facility is 4.8 million SWU. For comparison, the World Nuclear Association reports that worldwide capacity in 2015 was approximately 59 million SWU and is expected to grow to almost 67 million SWU by 2020, with the vast majority of that growth in Russia and China.[71] UxC reports a base case nameplate capacity of [redacted] UxC projects [redacted]. UxC Enrichment Market Outlook, Quarter 1 2017, 46. Some of the capacity additional may be to maintain centrifuge manufacturing capabilities and some of it will be offset by slight capacity reductions in Europe. URENCO is reducing its capacity slightly by not replacing aging centrifuges at its European sites. 2017 ERI Report, 16.

1. *Prices for enrichment services*

Like prices in the uranium concentrates and conversion markets, prices in the enrichment market are described in terms of spot and term price. The following section discusses the potential impact of DOE transfers on these two prices. For reference, as of April 17, 2017, the spot price indicator was $47 per SWU and the term price indicator was [redacted] per SWU.[72] DOE obtained information about enrichment services prices from ERI and the UxC Enrichment Market Outlook Report for Quarter 1 of 2017. URENCO also provided information on prices in comments in response to the NIPC. NIPC Comment of URENCO, at 2. URENCO noted price declines since its comments to DOE in September 2016 on the RFI, from a spot price of $55/SWU and term price of $64/SWU to an April 2017 spot price of $47/SWU and term prices of $50/SWU. Id.

Like uranium and conversion markets, the enrichment market includes significant sources of secondary supply. The enrichment market is also characterized by excess capacity and very limited near-term demand. Finally, there is not a large gap between spot and term prices for enrichment, as there is for conversion. On the other hand, buyers may be more sensitive to enrichment prices because enrichment constitutes a larger portion of the total cost of enriched uranium product[73]

To be conservative, DOE will assume that a competitive price-setting mechanism does determine enrichment prices. On that assumption, ERI's market-clearing price methodology 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.

i. Energy Resources International Report

In the 2017 ERI Report, like the 2015 ERI Report, ERI estimated the effect of DOE transfers on the market prices for enrichment services using a market clearing price methodology. Like uranium concentrates and conversion, ERI conducted the clearing prices analysis on both an annual and cumulative basis, constructing individual supply and demand curves for enrichment services and estimating the clearing price with and without DOE transfers. ERI Report, 44. The same DOE transfer scenarios described in Section IV.A.1 were used in the analysis.

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[71] World Nuclear Fuel Report 2015, available at http://www.world-nuclear.org/information-library/nuclear-fuel-cycle/conversion-enrichment-and-fabrication/uranium-enrichment.aspx (accessed April 6, 2017). DOE believes that the Chinese capacity is being built for indigenous needs and that Russia's enrichment plans have slowed down since the WNA numbers were compiled.

[72] UxC, UX WEEKLY, April 17, 2017 (Volume, 31, Number 16) at 1.

[73] 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.

Unlike the uranium concentrates and conversion prices, however, there is no difference in ERI's estimated price effect between any of the four scenarios because EM transfers of natural uranium do not include an enrichment component. Instead, the price effects indicated in the analyses are attributable to the planned NNSA transfers of LEU for national security purposes and past transfers of LEU that continue to displace supply in the market. The price effects are presented here and included as part of DOE's consideration and analysis of whether or at what level to conduct EM uranium transfers. Because there is no difference in price effects between the scenarios, there is no marginal or incremental price effects to be considered.

Using the market clearing price model, on an annual and cumulative basis, ERI estimates the market clearing price with and without DOE inventory and the difference is the effect that DOE transfers will have on the market clearing price for the enrichment services industry listed in Tables 12 and 13, respectively. The "No DOE Transfers" market clearing methodology models the market as though no transfers have taken place since 2009, so the price effects attributed to DOE inventory are already built into the current market prices. If no DOE inventory release had taken place, then future market prices would be higher by the amounts stated. 2017 ERI Report, 54.

	ERI – All Scenarios
2017	$1.40
2018	$1.80
2019	$1.70
2020	$0.10
2021	$1.70
2022	$1.70
2023	$0.10
2024	$0.10
2025	
2026	
Average (2017 – 2026)	$0.90

Table 12. ERI's Estimate of Effect of DOE Transfers on Enrichment Prices in $ per SWU (Annual Market Clearing Approach)

	ERI – All Scenarios
2017	\$9.70
2018	\$8.80
2019	\$7.30
2020	\$8.80
2021	\$14.90
2022	\$10.50
2023	\$10.10
2024	\$2.60
2025	\$7.50
2026	\$1.30
Average (2017-2026)	\$8.20

Table 13. ERI's Estimate of Effect of DOE Transfers on Enrichment Prices in \$ per SWU (Cumulative Market Clearing Approach)

As noted above, ERI also presented information on the cumulative clearing price effect relative to "No DOE" clearing price for enrichment services, where the "No DOE" clearing price assumes that DOE releases from 2009 onward were zero. 2017 ERI Report, 58.

Table 14 presents the price effect as a percentage of "No DOE" clearing price from Table 4.9 in the 2017 ERI Report, which provides an assessment of price impacts for the period 2017 to 2026 as an estimated percent change in enrichment clearing price attributable to the DOE inventories under the four scenarios relative to the "No DOE" market prices. As with Tables 12 and 13, there is no difference in the percentage of the price effect among the four scenarios, and therefore a calculation of the marginal or incremental effect is not conducted.

	ERI – All Scenarios
2017	12%
2018	11%
2019	9%
2020	10%
2021	16%
2022	11%
2023	11%
2024	3%
2025	8%
2026	1%
Average (2017 – 2026)	9%

Table 14. Cumulative Enrichment Price Effects as Percentage of "No DOE" Clearing Price

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

ii. Effect of DOE transfers on market prices

Based on the foregoing discussion of market analyses and DOE's consideration of the information, DOE concludes that the level of EM transfers will not have a direct effect on the market price for enrichment. ERI's market clearing price analysis shows no difference in price between the scenario with no EM transfers and the scenarios with different levels of EM transfers. Separate and apart from the EM transfers that are the subject of this determination, DOE's transfers for NNSA down-blending and historical transactions involving LEU that continue to displace market supply will affect the SWU price because they contain an enrichment component. ERI estimates that DOE transfers of LEU will suppress the market price of enrichment on average in the next decade either $.90 or $8.20 per SWU, based on the annual and cumulative clearing price approach, respectively. We note that the average near-term effect using both methodologies is somewhat larger, $1.63 (annual) or $8.60 (cumulative) per SWU. This is understandable, since the near-term includes the NNSA transfers for LEU down-blending that will cease by 2019. The price effect significantly diminishes toward the end of the decade, when past transactions in addition the NNSA LEU down-blend transfers are no longer entering the market.

As in the uranium concentrates and conversion industries, the significance of price suppression at this level depends, in part, on current and forecasted market prices. As stated above, the April 17, 2017 spot price indicator was $47 per SWU and the term price indicator was [redacted] per SWU. UxC Weekly, Volume 31, Number 136 at 1. Using the annual method forecast, the price effect in the next decade reasonably attributable to DOE transfers represents about 2% of these current market values; the price effect in the near-term is about 3.5%. According to UxC's Quarter 1 Enrichment Market Outlook, 112, spot prices for SWU dropped [redacted]. Similarly, term price fell from $[redacted] by year's end. These represent declines of 22% and [redacted]%, respectively. Compared to these large overall price swings, price effects of 2-3.5% are well within the normal range of market fluctuations. Even under the cumulative method, with an average decline over the decade of $8.20/SWU would yield a price decline of 17%, still within the range of recent market fluctuations.

To reiterate, while DOE has considered here the projected price effect of the NNSA and other LEU transfers under all scenarios, the effect of only the EM transfers is the question this analysis must address. As noted earlier, EM transfers would have a small price effect on both the uranium and conversion markets. There is the possibility that DOE transfers of natural uranium could still have an effect on SWU prices indirectly due to the prevalence of "underfeeding" or re-enrichment of tails. The amount of enrichment devoted to underfeeding at any given time depends in part on the relative prices of natural uranium hexafluoride and enrichment. Because EM transfers suppress the price of natural uranium without directly affecting the enrichment market, they tend to indirectly suppress the SWU price as well due to this interaction. Although ERI does not attempt to quantify this indirect effect on the SWU price, DOE notes that in the 2015 Secretarial Determination and Analysis, DOE estimated that transfers at levels equivalent to the Base Scenario would cause enrichers to devote less primary supply to underfeeding by about 200,000 SWU. Based on available information, DOE cannot attribute a specific price effect to this interplay, but given the size of the effect compared to URENCO's nameplate capacity—4.8 million SWU at UUSA and between 13-15 million SWU in the EU—DOE believes that this effect is small enough not to affect the conclusion that continuing the EM transfers of natural uranium at either the Base Scenario rate or the 1,200 MTU per year rate beginning in May 2017 would not have an adverse material impact on the U.S. enrichment industry.

iii. Effect on realized prices

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 price indicators published by TradeTech and UxC are based on market 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. In 2015, of the total 54.5 million pounds U_3O_8 equivalent purchased by owners and operators of U.S. civilian nuclear power reactors, 78% was sold on long-term contracts. The price paid for enriched UF_6 under the long-term contracts versus spot contracts was \$43.28 and \$33.37, respectively. EIA Uranium Marketing Annual Report, 26 (2016). Consequently an enricher's actual revenues are somewhat insulated from short-run fluctuations in price.

URENCO's Full-Year Audited Financial Results for 2016, which was submitted to the Department as part of URENCO's NIPC comments, reports a contract backlog that with a value of €15.5 billion that extends into the latter half of the next decade. URENCO states that it will experience lower profit margins and reduced cash flow if pricing pressures persist in the middle and long-term. Specifically, URENCO states it will feel the impact of lower SWU prices "primarily from the second half of the next decade, as until such time the majority of our revenues are at contracted prices." NIPC Comment of URENCO, Enclosure 1, at 1. [redacted] UxC Enrichment Market Outlook, Quarter 1 2017, 21. Based on this information, DOE concludes that URENCO is currently producing SWU to fulfill its existing contracts, but it is unlikely to enter into new term contracts for significant volumes in the near future. Therefore, it does not appear that the SWU price suppression attributable to DOE transfers will have an appreciable effect on URENCO's realized price in the near-term.

EM transfers are expected to have an effect on the uranium concentrate and conversion prices, as described in Sections IV.A.1 and IV.B.1. URENCO notes that a portion of UUSA's capacity is dedicated to underfeeding and re-enrichment of depleted tails but does not provide data regarding its sales in these markets. ERI notes that URENCO estimated in 2013 that it uses 10-15% of its capacity for underfeeding or re-enrichment of tails. 2017 ERI Report, 93. To the extent that URENCO sells the natural uranium that is the result of its underfeeding and re-enrichment on the spot market, it will receive a realized price that is lower by the level of the price suppression described above—on average over the next decade, \$1.40 per pound U_3O_8 for uranium concentrates and \$0.30 per kgU for conversion services. Based on available information, DOE is unable to determine the specific volume of natural uranium that URENCO sells on the spot market, but DOE reiterates its conclusions from the sections above that the price effects are within the range of those exhibited by normal market fluctuations.

2. *Production at existing facilities*

As discussed above, the only existing US enrichment facility is the UUSA gas centrifuge facility in New Mexico. URENCO reports a current capacity of 4.8 million SWU and notes that the regulatory approvals are in place to expand capacity.[74] ERI reported that UUSA capacity is projected to increase to 5.7 million SWU by 2022, which we understand to be the completion of UUSA's Phase 3. 2017 ERI Report, 16. [redacted]. UxC Enrichment Market Outlook, 54. As noted earlier, the capacity expansion will serve to support an ongoing centrifuge manufacturing capability. URENCO's NIPC comments at 3 note that URENCO has cancelled Phase 4 of its construction plans at its plant in New Mexico, which would have added 2 million SWU capacity, because of market conditions. ERI also reports that, in 2016, URENCO reduced its production capacity at the Capenhurst site when it mothballed two production halls (out of 15). URENCO has also made small capacity reductions by not replacing aging centrifuges at its European sites when centrifuges go out of service. 2017 ERI Report, 16.

ERI's November 2016 Reference forecast for enrichment services requirements projects that annual world requirements for enrichment services in 2016 are 45.4 million SWU, but are then projected to increase to 49 million SWU in 2017. 2017 ERI Report, 14. U.S. requirements are projected to be essentially flat, averaging almost 15 million SWU per year between 2016 and 2035. The updated projections for average U.S. requirements for uranium and conversion services are lower than those used in the February 2015 ERI market analysis, although enrichment requirements have increased somewhat due to lower tails assay assumption. Projected U.S. uranium and conversion requirements have declined by 2% while U.S. enrichment requirements increased by 4%.

URENCO's internal estimates suggest that global SWU inventories represent nearly two-year's worth of 2016 global SWU requirements. RFI Comment of URENCO, at 3. URENCO also notes very limited uncommitted demand in the next few years and notes that DOE inventories compete for these very limited pools of demand. Further, URENCO opines that the combination of low demand and excess supply is placing downward pressure on prices for uranium enrichment services, pointing out that prices have fallen considerably from the $79/90 spot/term prices at the time of the May 2015 Secretarial Determination. URENCO's 2016 Annual Results state that "URENCO anticipates continued short to medium term pricing pressures until worldwide fuel inventories are reduced which may impact future profit margins." The 2016 Annual Results also note that the company is confident that global nuclear industry will continue to grow.[75] Finally, these financial results note that URENCO is benefitting by the strength of the U.S. dollar in that two-thirds of its revenue is in U.S. dollars. The projections for increasing requirements for U.S. enrichment are expected to generate increased production at the UUSA facility.

DOE does not believe that its uranium transfers will have a significant effect on production at the only existing U.S. uranium enrichment facility.

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[74] URENCO, 2015 Annual Results Presentation, http://www.urenco.com/_/uploads/results-and-presentations/160301_URENCO_end_of_year_results_presentation_FINAL.pdf (Accessed February 7, 2017).

[75] Id.

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. However, URENCO shared in its NIPC comments that it expects to reduce our 2016 workforce of 280 by 50 employees "in the near-term." URENCO NIPC comment at 3. URENCO does not state what proportion of this employee reduction it believes is attributable to DOE transfers. DOE is not able to independently assess what, if any, portion of this 18% workforce reduction is attributable to DOE transfers, but believes it is reasonable to conclude that the DOE transfers do not contribute in significant part given other market conditions and factors.

4. *Changes in capital improvement plans and development of future facilities*

As noted above, ERI reports that URENCO USA capacity increased to 4.6 million SWU by the end of 2015, with plans to slowly increase to 5.7 million SWU by 2022. 2017 ERI Report, 25.

Another planned enrichment facility was announced by Global Laser Enrichment, a venture of GE-Hitachi and Cameco. The proposed facility will use laser enrichment technology developed by Silex Systems to enrich depleted uranium tails to the level of natural uranium, at a proposed location near Paducah, KY.[76]

The U.S. Nuclear Regulatory Commission granted two additional licenses for centrifuge enrichment plants. Centrus holds a license for the American Centrifuge Plant in Piketon, Ohio, while AREVA Enrichment Services holds a license for the Eagle Rock Enrichment Facility, planned for Bonneville County, Idaho. However, on March 10, 2017, AREVA informed the NRC that it does not plan to construct the Eagle Rock Enrichment Facility and asked that its license be terminated. The American Centrifuge Plant is not currently being developed; Centrus' website indicated that the company "is continuing to explore technology refinements and other ways to deploy the most cost effective commercial enrichment capacity taking advantage of the current period of time when capacity expansion is not needed in the market."[77] NRC also issued a license to GE-Hitachi for a laser enrichment facility in Wilmington, North Carolina. Development of that facility is also on-hold and GE-Hitachi has announced its plans to sell its shares and exit that venture.

As outlined above, planning for improvements or development of future enrichment facilities has slowed significantly due to market conditions. As previously noted, URENCO is currently working on Phase 3 of its New Mexico plant, which is expected to bring capacity to 5.7 million SWU but has cancelled the previously planned 2 million SWU Phase 4.

5. *Long-term viability and health of the industry*

URENCO indicates that pressures on pricing and on competition for limited demand "present significant challenges for the United States' only enrichment plant." The comments also indicate that some of UUSA's capacity is being directed towards underfeeding and for re-enrichment of its

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[76] Energy Department Announces Agreement to Sell Depleted Uranium to be Enriched for Civil Nuclear Power, (Nov. 11, 2016), https://energy.gov/pppo/articles/energy-department-announces-agreement-sell-depleted-uranium-be-enriched-civil-nuclear (accessed February 22, 2017).

[77] CENTRUSENERGY.COM, http://www.centrusenergy.com/what-we-do/national-security/american-centrifuge/ (accessed April 14, 2017)

depleted tails so that URENCO is therefore affected by market pressures in the uranium and conversion markets. NIPC Comment of URENCO at 3.

With total world enrichment supply currently projected to exceed requirements for enrichment services by a significant margin over the long term, it is expected that enrichers will continue to redirect excess enrichment capacity to underfeeding and re-enrichment of tails. The uranium market will continue to be of interest to enrichers as unfilled requirements in the uranium market increase in the future. Note, however, that this does put additional pressure on uranium producers. Unfilled requirements in the enrichment market are also projected to increase in the future. The sole U.S. enricher is currently benefitting from a strong U.S. dollar exchange rate.

URENCO indicated that these pricing pressures have "a direct impact" on UUSA and pointed to a non-cash impairment charge against its UUSA operation of more than $800 million (€ 760 million) on its Full-Year 2016 Audited Financial Statement. URENCO's Full-year 2016 Audited Financial Statement takes note of the pricing pressures facing the parent company and the enrichment market, but note that 'we believe that the combination of our current robust finances coupled with our new strategic direction will enable us to remain a reliable and sustainable partner in the global nuclear industry…."

As noted in Section IV.A. 5 above, nuclear power requirements are expected to grow in the future. Increases in demand will minimize the need for enrichers to underfeed and/or re-enrich tails, which will also take pressure off the uranium and conversion markets. To the extent that enrichers have significant backlog of long-term contracts, some of which were likely signed prior to the 2011 Fukushima Daiichi accident that significantly changed market dynamics, the impact of DOE uranium transfers on the U.S. enrichment industry's will not have an adverse material impact on the long-term viability and health of that 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. 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.ii, 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).

As mentioned above, in September 2016, the Department of Commerce proposed to adjust the export limits under the agreement to take account of changes in projected reactor demand. The proposed adjusted limits would allow an additional 990,000 SWU from Russia into the United States between 2016 and 2020. The additional amount varies by year, but on average, the proposed limits are 6.6% higher than current limits.

Material imported from Russia in accordance with the Suspension Agreement is derived from primary production rather than from down-blended HEU. The 2017 ERI Report takes account of enrichment entering the United States market under the current Suspension Agreement limits as part of total worldwide primary supply. The 2017 ERI Report does not consider the effect of the additional amount that would be allowed into the United States were the Department of Commerce to adopt the adjusted limits as proposed.

DOE believes that it is still appropriate to rely on ERI's analysis without adjusting for the proposed changes to the Suspension Agreement quota limits. It bears emphasis that the volume of the proposed adjustment is small relative to the current limits under the Suspension Agreement, to United States requirements, and worldwide requirements. Nominally, the adjustment adds no more than 410,000 SWU in any given year—and as low as 70,000 SWU in 2017 and 2019. DOE's analysis already takes into account the amount of SWU entering the United States from Russia under the current limits, and DOE does not believe that the adjusted limit would significantly alter DOE's analysis even if adopted.

7. *Enrichment industry conclusion*

In this analysis, DOE has considered the above six factors and the effect of all DOE transfers on the U.S. enrichment industry, including the NNSA transfers which are not the subject of this determination. DOE is cognizant of the challenges in the enrichment market.

The NNSA LEU transfers for down-blending are the only forward looking transfers that would have a direct impact on the U.S. enrichment industry and are not the subject of this Determination. EM transfers have no direct effect on enrichment prices, but even if they did, URENCO currently realizes prices under its existing contract book of long-term contracts and is not expected to enter into an appreciable volume of new long-term contracts in the near future without a very significant increase in SWU prices. Thus, even if EM transfers did directly affect the enrichment prices and price suppression from DOE LEU transfers were included, there would not be any appreciable effect on URENCO's current realized price for enrichment services, employment at UUSA, or plans for capital improvement or expansion. Similarly, other potential entrants into the domestic enrichment market would require prices so much higher than current prices that DOE transfers, even including LEU, would not affect investment decisions with respect to new plants.

That said, due to the enrichment industry practice of underfeeding and re-enriching tails, DOE concludes that the EM transfers of natural uranium will have a small impact on the U.S. enrichment industry due to the price suppression in the uranium and conversion markets attributable to the transfers described above. Given that URENCO is primarily in the business of providing enrichment services, that it devotes 85% of more of UUSA's capacity to primary enrichment, and the fact that the price suppression on the spot prices for uranium concentrates and conversion is relatively small—$1.40 per pound U_3O_8 for uranium concentrates and $0.30 per kgU for conversion—the effect on URENCO would be relatively small and not one of real import or great consequence such that it would constitute an adverse material impact on the domestic enrichment industry.

V. Other comments

A number of commenters throughout the public participation process have expressed views on matters that were not specifically within the scope of this Determination, or may be related to the topic of DOE's uranium transfers but not specifically its Determination of adverse material impact.

Some commenters commended DOE for undergoing an open and public process on this Determination, e.g., NIPC Comment of Duke Energy, at 1, while others commented that greater transparency in DOE uranium management and planning was important to promote predictability and stability in the nuclear fuel market. NIPC Comment of NEI, at 2. Some commenters supported DOE's transfers as a means to support continued cleanup at the Portsmouth site, FBP Comment, and others commented that funding for such activities should be obtained from Congress through appropriations. *See* NIPC Comment of Duke Energy, at 1, NIPC Comment of NEI, at 3. Comments ranged from requesting DOE halt all uranium transfers, NIPC Comment of UPA, at 2, 17, to, in the alternative, limiting DOE transfers to the least harmful of the three options, Scenario 2. NIPC Comment of ConverDyn, at 2

Certain comments from the public were out of scope of this Determination.

Several members of the public requested that DOE transfer all surplus uranium to American reactors and cease exporting any uranium to foreign countries. NIPC Comment of Anne Marie Zeller at 1; NIPC Comment of Dawna Papenhausen, at 1. Other commenters' statements regarding the amount of uranium imported to power domestic nuclear reactors is illustrative only as to the international nature of the uranium markets. See, e.g., NIPC Comment of enCore Energy, at 1. U.S. origin uranium is not required for U.S. reactors to meet demand and, as demonstrated in this Analysis, much of the uranium used in domestic reactors is obtained from foreign suppliers.

Comments related to proposed legislation also are outside the scope of this Determination. NIPC Comment of UR-Energy, at 2. The Administration has not taken a formal position on proposed legislation related to uranium management. In addition, UPA's comment as to the fair market value received for DOE transfers is outside the scope of this Determination, which addresses only the requirements of section 3112(d)(2)(B) regarding market impacts. NIPC Comment of UPA, at 16-17. DOE evaluates whether it receives fair market value prior to each transfer through a separate process. Lastly, UPA's call for DOE to withdraw the December 2016 national security determination is outside the scope of this Secretarial Determination and Analysis, which only considers future EM transfers. NIPC Comment of UPA, at 2.

Commenters also requested DOE consider foregoing the down-blend of highly enriched uranium to 5% enrichment or below in anticipation of demand for high-assay LEU not available currently in the market for use in advanced nuclear reactors and advanced nuclear fuel development. NIPC NEI Comment, at 2. In consideration of these comments, and notwithstanding policies suggested in proposed legislation, DOE is considering plans to issue a Federal excess uranium inventory management plan to provide additional information on DOE's uranium management planning and thereby increase transparency and reliability upon which the uranium industries can make investments and decisions.

VI. Conclusion

For the reasons discussed above, DOE concludes that transfers under either the 1,600 MTU or 1,200 MTU scenarios 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.