REPORT APPENDIX VOLUME

Solving America's Uranium Crisis—

Why Mining Domestic Uranium Is Vital To U.S. National and Economic Security

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This standalone appendix volume contains additional detailed and technical material that supports the report volume by the same title. The *Introduction* below briefly restates the issues stated in the report volume.

Included here is an important section on U.S. uranium abundance: *How Much Uranium Does the U.S. Have?* This section helps make the case for a strong domestic uranium mining program by describing the vast extent of U.S. uranium deposits.

Appendix sections support the three main background sections (see Table of Contents) of the report volume: *Dangerous Decreases in U.S. Production; Strategic Importance of Reviving Domestic Uranium Production;* and *Disparity Between U.S. vs. State-Owned Uranium Companies*.

Introduction

Uranium probably always will be a critical material no matter how much of a supply the U.S. has because it is the only naturally-occurring fissile element on earth. It has no real satisfactory replacement for what it can do. The U.S. is importing over 90 percent of its uranium needs from a dozen countries around the world. Worse, it is over-reliant on Russia and two of its former satellite countries, Kazakhstan and Uzbekistan, for more than 40 percent of those imports

The U.S. has reached a tipping point regarding nuclear power because uranium represents one-fifth of the nation's power generating capability. The once thriving U.S. uranium industry that was self-sufficient in the 1970s through 1980 has been in free-fall along with much of the rest of the mining industry over the past several decades.

Although the U.S. has abundant uranium resources, it is classified as a mineral fuel that has a substitute in natural gas and renewable energy, meaning its resource abundance or supply is not as important as its demand. This is why reversing a 99 percent import over-reliance, much of it on cheap foreign uranium, will be very difficult under current market conditions.

Sustained over-reliance on foreign uranium especially from adversaries, without a plan to reverse that dependency, is absolutely counter to the nation's security. In addition, it flies in the face of basic understanding of geology, economics, trade policy, geopolitics, and technology surrounding the U.S.' uranium abundance and use. Many of the same issues that plague the uranium industry are similar to those which caused the nation's over-dependence on China for rare earths.

How Much Uranium Does America Have?

Areas containing the major U.S. uranium deposits and production are in the Western states, including Arizona, Colorado, Wyoming, Nebraska New Mexico, Utah, and Texas. (Virginia also has a surprisingly large untapped source of uranium located along its southern border in Pittsylvania County). Some Western state locations were made famous by their association with the discovery and mining of uranium.

For example, Arizona's uranium occurrences are known throughout the state in a variety of different geologic settings. By far the most uranium production has been from the Colorado Plateau known as the northern "Arizona Strip". Previous exploration there has resulted in the discovery of numerous "breccia pipe" ore bodies.

These deposits are attractive exploration targets because they represent the highest grade deposits identified thus far in the U.S.[1] In addition, a key environmentally friendly characteristic of breccia pipe mining is the very small footprint for each mining operation.

A typical breccia pipe, shaped like a giant cylinder or funnel, is about 300 feet in diameter and may extend 3,000 feet beneath the surface. Thousands of pipes occur at or near the surface in this region of Arizona, but only about one percent of them contain uranium ore. Since the 1980s, dozens of uranium-ore-bearing breccia pipes had been identified that have excellent potential for development as orebodies. Total amount of mineable uranium discovered to date in northern Arizona is estimated to be in the range of 35 million pounds, but additional exploration will undoubtedly push that total much higher.[2]

Meanwhile, in Colorado, some of the U.S.' largest and highest grade deposits occur within the Rocky Mountain and Colorado Plateau provinces. Uranium also occurs in the Great Plains province of northeastern Colorado. However, on the Plateau in southwest Colorado, more than 1,200 uranium mine shafts and adits were driven from surface outcrop into sinuous uranium ore bodies in what is known as the Morrison Formation of dinosaur fossil fame. Following the uranium ore in the Morrison is difficult, and many mines were abandoned long ago. Modern exploration techniques suggest good prospects exist within southwestern Colorado and the central Rocky Mountains. Many abandoned Colorado uranium mines are being re-evaluated and production restarted.[3]

In northeast Colorado's Great Plains province, the uranium deposits do not outcrop at the surface, but are deeper underground, and are prime candidates for in-situ recovery. In-situ recovery is a relatively simple process whereby a mixture of groundwater and dissolved oxygen is pumped into a deeply buried mineralized sandstone, where it contacts, dissolves and leaches the uranium ore. The mineralized solution is then pumped back to the surface where the uranium is removed.[4]

Further north in Wyoming, uranium was first discovered in 1949, with production in the 1950s centered in the Gas Hills area and nearby Shirley Basin. Major discoveries in the late 1960s and 1970s occurred in the Powder River Basin and in neighboring Nebraska.

But conventional mine production peaked in 1980, and decreased through the 1980s. Many in-situ projects were placed on standby or shut down. However, at its peak, Wyoming uranium mining produced 12 million pounds annually, and roughly 210 million pounds of U_3O_8 since uranium was first discovered there.[5]

New Mexico's Grants Uranium Region has been the most prolific producer of uranium in the U.S. Since 1948, over 347 million pounds of U_3O_8 has been produced from the region during the forty years from 1950 through 1990. Billions of dollars have been spent exploring for and producing uranium in New Mexico since the 1960s, resulting in the discovery of classic uranium deposits in New Mexico's San Juan Basin.[6]

Texas contains many shallow uranium deposits along the lower coastal plain in deposits commonly associated with oil and gas resources. In fact, the Texas Gulf Coast Uranium Region has been a surprise major producer of uranium in the United States. Texas production initially began in the early 1960s, resulting in over 76 million pounds of U_3O_8. This represents one of the largest concentrations of uranium production in the U.S.[7]

Utah had the earliest uranium mining, beginning on a small scale in the 1870s and 1880s, with its ore shipped to France and Germany in 1884 for use in forming salts and oxides as colorants for ceramics and dyes, especially in the manufacture of glass and pottery, and also for use in photography and steel plating.

The eastern and southeastern regions near the basin margins of the Green and Colorado rivers contain deposits of uranium. There, Utah's famous uranium discoveries of the 1950s created another "bonanza" era in Utah mining, and within a five-year period, almost six hundred producers on the Colorado Plateau were shipping uranium ore. The associated bonanza in penny uranium stocks established Salt Lake City as "The Wall Street of Uranium."[8]

Today, southeast Utah is home to the lone operating conventional uranium processing mill in the U.S. known as White Mesa, owned by Energy Fuels Company. The nearby Ticaboo uranium mill, owned by Uranium One—the company embroiled in the controversial buyout of U.S. uranium by Russian interests—is currently on standby. A significant number of past active Utah uranium mines are considering restarting operations depending on continued uranium price increases. In addition to the existing infrastructure, a number of companies are carrying out exploration programs for new resource areas in Utah.[9]

Geologically, the U.S. would appear to have the potential for enormous uranium resources. However, despite the apparent abundance and the long history of uranium development in the

West, the U.S. is a relative lightweight regarding the amount of known recoverable resources of uranium compared to other countries.

Dangerous Decreases in U.S. Uranium Production

Russia

Russia clearly views the nuclear fuel cycle as a tool of geopolitical influence, and for many years it has systematically sought to degrade key elements of the U.S. industry. This has been recognized by national security specialists at such respected institutions as the Center for Strategic and International Studies ("CSIS").

The global uranium industry has recently been characterized by a number of transactions that have led to significant consolidation, including consolidation occurring in the U.S uranium industry in response to low commodity prices and cost cutting requirements. The common business objective has been to attempt to build a stronger company in weak markets and streamline costs. Rosatom, the Russian state-owned company, has exploited these transactions, not only provide access to dominate new markets, but also to support Russia's foreign policy objectives. [10] [11]

Rosatom is effectively the Russian nuclear industry. In the fourth (and most recent) Sunset Review of the Russian Suspension Agreement, "Uranium from Russia, Investigation No. 731-TA-539-C (Fourth Review)," the ITC described Rosatom as follows:

"The main organization in the Russian nuclear industry is Rosatom. As described by the WNA, 'The State Corporation (SC) Rosatom is a vertically-integrated holding company which took over Russia's nuclear industry in 2007, from the Federal Atomic Energy Agency (FAEA, also known as Rosatom). This had been formed from the Ministry for Atomic Energy (Minatom) in 2004, which had succeeded a Soviet ministry in 1992. The civil parts of the industry, with a history of over 60 years, are consolidated under JSC AtomEnergoProm (AEP).'

"Rosatom holds all of the shares of AEP, which is a single vertically-integrated state holding company for the country's nuclear power sector (separately from the military complex). It incorporates more than 80 enterprises operating across the nuclear fuel cycle. Among its entities include ARMZ (a uranium mining firm); Tenex (exporting arm of Rosatom and executive agent for the Russian government for the HEU agreement, and which also has a North American subsidiary now called TENEX-USA Inc.); Uranium One Group (based in Canada and focused on uranium mining in non-Russian markets); and TVEL (conversion, enrichment, and nuclear fuel fabrication). Many of these firms operate as joint stock companies."[12]

Government owned uranium producers, such as those in Russia, receive production facilities, financing for the construction and operation of production facilities, access to known deposits and reserves, exploration and other data, preferential tax treatment, devalued currencies, and other valuable benefits directly from their government. For example, the following excerpt describes the Russian approach:

"There is high-level concern about the development of new uranium deposits, and a Federal Council meeting in April 2015 agreed to continue the federal financing of exploration and estimation works in Vitimsky Uranium Region in Buryatia. It also agreed to financing construction of the engineering infrastructure of Mine No. 6 of Priargunsky Industrial Mining and Chemical Union (PIMCU). The following month the Council approved key support measures including the introduction of a zero rate for mining tax and property tax; simplification of the system of granting subsoil use rights; inclusion of the Economic Development of the Far East and Trans-Baikal up to 2018 policy in the Federal Target Program; and the development of infrastructure in Krasnokamensk."[13]

Russia, using Rosatom and its subsidiaries including Uranium One, is able to leverage its regional influence to gain favorable terms from other countries, such as Kazakhstan, including the ability to acquire control of approximately 40 percent of Kazakhstan's uranium production today. In this instance, on May 2009, Uranium One, a publicly traded Canadian corporation with assets in the U.S. and Kazakhstan, announced that the government of Kazakhstan was investigating the validity of their subsoil licenses for their majority-owned uranium projects in Kazakhstan.[14]

The investigation ended favorably following a complicated transaction with AtomRedMetZolo ("ARMZ") (a wholly-owned subsidiary of Rosatom). In that transaction, Uranium One acquired a 50 percent interest in the Karatau uranium mine located in Kazakhstan, and ARMZ received shares in Uranium One that resulted in Rosatom gaining a 16.6 percent ownership stake in the company.[15]

In January 2013, ARMZ announced that it would acquire 100 percent of the remaining, outstanding shares of Uranium One with an intention to take the company "private" (meaning that Uranium One would become a 100 percent state-owned enterprise of Russia and not a publicly-held company listed on a major stock exchange). The transaction was to take place through a cash payment of Russian currency from ARMZ to UraniumOne estimated to be valued at US$1.32 billion.[16]

The result of this transaction is that all of ARMZ uranium production from Kazakhstan has been consolidated into Uranium One directly under Rosatom. Russia continues to control approximately 40 percent of Kazakh uranium production, which (among other things) it uses to circumvent the Russian Suspension Agreement that ostensibly limits Russian imports to the U.S.

Another case where the state ownership of Rosatom allows Russia to leverage additional market control at the expense of the U.S. uranium industry and U.S. national security is its enrichment strategy including its business arrangement with Centrus Energy Inc., formerly U.S. Enrichment Corporation (USEC). As evidence of its anti-competitive practices, Rosatom boasts on its website that it "covers 17 percent of global nuclear fuel market.

The company did not lose a single nuclear fuel supply bidding in 10 years." In a vacuum, Rosatom does not utilize any special technology or have any particular cost advantage. Therefore, this could not occur without some sort of other non-market advantage. Russia holds approximately 40 percent of the world's current enrichment capacity.[17]

Centrus Energy is slated to become the sole U.S. enricher at some point in the future, and it oversees the intellectual property for the American Centrifuge Plant ("ACP"), which is expected to be used for the enrichment of non-obligated uranium for U.S. national security needs (after USEC/Centrus was stripped of its control of the ACP, the technology was placed under the guidance of the Oak Ridge National Laboratory).[18]

In the meantime, Centrus is simply an agent that brokers Russian uranium products into the U.S. As noted earlier, Techsnabexport ("Tenex"), is the principal exporter of uranium products and uranium enrichment services under its parent company Rosatom.[19]

Tenex was the executive agent for the Russian Government under the HEU Agreement and established a U.S. subsidiary, TENAM Corporation, which is now called TENEX-USA Inc. ("TENEX-USA"), which markets Russian nuclear products directly to U.S. customers. In 2011, USEC (now Centrus Energy Corporation) and Tenex entered into a supply agreement under which Tenex would supply USEC with low-enriched uranium (LEU) to fill long-term contracts USEC had with U.S. utilities and other buyers.

Prior to the expiration of the HEU Agreement in 2013, USEC supplied Russian-origin LEU from the HEU program to U.S. utilities. Starting in 2013, coincident with the conclusion of the U.S.-Russia HEU Agreement, Tenex agreed to supply USEC with up to half of the volume of LEU that USEC received under the HEU Agreement for a period of 10 years. As USEC no longer has the ability to enrich uranium on its own behalf this agreement effectively established USEC—a U.S.

company that formerly enriched uranium for U.S. commercial reactors – as a marketing agent for Russian LEU.[20]

Unlike the U.S., Russia has maintained its Cold War enrichment capacity, and they now are the largest source of enrichment capacity in the world. As a comparison, Russian annual enrichment capacity is 27.5 million Separative Work Units ("SWU") with an average production cost of $53/SWU. By comparison, URENCO-USA ("LES", or Louisiana Energy Services) in New Mexico (the only commercial enrichment currently occurring in the U.S.) has an annual enrichment capacity of only 4.6 million SWU with an average production cost of $73/SWU.[21]

Russia's overcapacity of enrichment provides significant market strength for Russia through its state company, Rosatom. With the backing of the state, Rosatom is able to sell enrichment services well below costs. More recently, TENEX, Rosatom's enrichment marketing group is now promoting the direct purchase of enriched uranium product ("EUP"), leveraging their ownership of Kazakh uranium from Uranium One and the Russian government's enrichment infrastructure to concentrate market share even more.[22]

This approach allows TENEX to sell EUP as a bundled unit containing natural uranium, conversion, and enrichment that creates further opportunities for anti-competitive and predatory pricing. U.S. uranium miners, convertors, and enrichers are unable to match this practice due to antitrust laws and other ways the U.S. uranium market is structured. In other words, Russia is exploiting its state-owned enrichment advantage and ownership of uranium mines around the world to the detriment of free-market uranium mining, conversion, and enrichment.

Much of this was made possible by the Russian government giving Rosatom and its subsidiaries oversight "over all aspects of the country's nuclear industry, ranging from weapons to medicine. This includes oversight and use of several Cold War era enrichment facilities, including Novouralsk, Zelenogorsk, Seversk, and Angasrk. Therefore, rather than investing the billions of dollars that it would have taken to build these facilities (as would happen in the West), TVEL, TENEX, and TENEX-USA enjoy an enormous government-sponsored competitive advantage over their free-market competitors.[23]

Kazakhstan

In the early 2000's, Kazakhstan, a former Soviet Republic with continued significant economic and strategic ties to Russia, adopted a national policy to increase uranium production and exports. In 2009, Kazakhstan became the global leader in uranium production. Since 2011 when the price of uranium reached $70 per pound, Kazakh production relentlessly continued to increase, peaking at over 60 million pounds of U3O8 in 2016, despite prices having then dropped to below $20 per pound. Kazakhstan has 12 percent of the world's uranium resources, but, as described below, its share of the global and U.S. markets have exceeded that figure and increased significantly over the last decade.[24]

Kazatomprom, is Kazakhstan's state-owned enterprise for the production and export of uranium. Until 2018, Kazatomprom was 100 percent owned and controlled by Kazakhstan's sovereign wealth fund, Samruk Kazyna. In November 2018, Samruk Kazyna initiated an initial public offering ("IPO") of 15 percent of the stock of Kazatomprom. Approximately, one-third of the total IPO was purchased by Kazakhstan's state-run pension fund in order to support the public float.[25]

The ability of the government to support the IPO in such a manner provides a major source of financing for direct government support for Kazatomprom. The remainder of the stock offered in the IPO was purchased by other companies around the world. Therefore today, Kazakh government-owned entities own about 90 percent of the stock of Kazatomprom, which represents an overwhelming controlling interest.

Nonetheless, the IPO prospectus provides the most transparent look into the relationship between Kazatomprom and the Kazakh government. An excerpt from the prospectus details the special privileges held by the company:

"The Company enjoys the status as Kazakhstan's national operator for the export and import of uranium and its compounds, nuclear power plant fuel, special equipment and technologies, as well as rare metals. The respective status of a national company in Kazakhstan allows the (Kazatomprom) Group to benefit from certain privileges, including, among other things, obtaining subsoil use agreements through direct negotiation with the Government rather than through a tender process which would otherwise be required.

This effectively grants the Group priority access to such opportunities, including the high-quality and ISR-conducive deposits of natural uranium, which are abundant in the Republic of Kazakhstan."[26]

Kazakhstan has been a phenomenon in the growth of production since the late 1990's to early 2000's. It has principally succeeded in this accomplishment this feat through investment generated by JV partnerships with western partners from Japan, Canada, and France.

Kazatomprom has not acted in a market responsible manner and has utilized its government ownership and control of these deposits (most of which were discovered during the Soviet era) to extract concessions from foreign partners. Starting in the late 1990's, Kazakhstan nationalizes significant foreign ownership of subsoil licenses previously held by World Wide Minerals Ltd.:

"Perhaps the largest sword of Damocles hanging over Kazatomprom (referring to the IPO) is a looming arbitration award in a long-running dispute with Canada's World Wide Minerals, which sunk significant capital into Kazakh uranium assets and was all but destroyed in the late 1990s after a government policy shift resulted in uranium export license denials (NIW Dec.20, 2013; NIW Nov.19, 2007)."[27]

World Wide Minerals sued the Kazakh government for this taking, and an arbitration decision and award is imminent. Kazatomprom has also used its leverage with the government to slowly nationalize JV partnerships with western partners.

In some cases, this move has provided opportunities for greater ownership by Chinese and Russian state-owned companies with more favorable terms than the western JV partners were able to obtain: …details of the company's deals with Rosatom subsidiary Uranium One and Canada's Cameco have been made public, but documents associated with its initial public offering (IPO)—suggest brash, if not ruthless, treatment of French and Japanese partners as the Kazakh company muscled its way into existing arrangements to scoop up more offtake, dividends and profit.

Kazatomprom will soon own 50 percent or more of nearly all Kazakh uranium mines. Meanwhile, its Chinese JV partner China General Nuclear (CGN) was ushered further into the country's uranium industry via an offer to participate in one of the country's most attractive uranium mines.[28]

The ownership of Kazatomprom by Kazakhstan's government-owned sovereign wealth fund, provides a significant advantage due to its ownership of other affiliates that are suppliers to Kazatomprom. These related parties provide Kazatomprom and their JV partners a significant cost advantage as compared to U.S. and other free-market uranium producers.

For example, sulfuric acid represented more than 50 percent of the group's and its JVs' and Associates' expenses for mining supplies. The Group and its JVs and Associates sourced 32.5 percent, of its sulfuric acid collectively from SKZ-U LLP in which the Company holds a 49 percent interest and SKZ Kazatomprom LLP, a subsidiary of the Company's sole shareholder Samruk-Kazyna and in which the Company has a 9.9 percent interest."

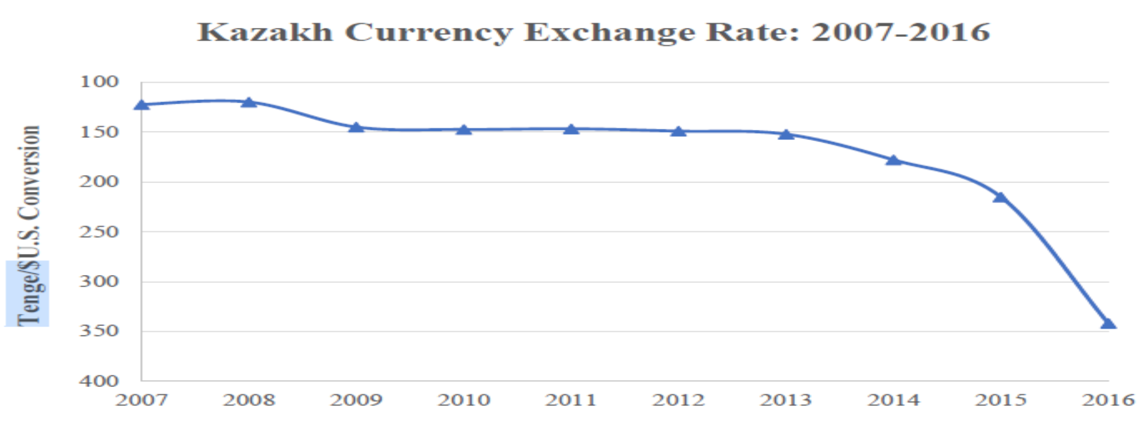
Major producing countries, such as Kazakhstan and Russia, also have different, far less costly environmental, health and safety standards than the U.S., which allow foreign uranium mining operations to recover uranium at a lower cost. U-232, it was estimated that these cost advantages totaled over $10 per pound of U_3O_8.

The biggest difference in the cost and environmental footprint of ISR mining methods is that sulfuric acid is used in Kazakhstan, whereas in the U.S. this approach is not currently accepted as a best practice due to the heavy metals it brings into solution, putting groundwater at risk. U.S. regulations require active groundwater restoration to remove heavy metals, so miners attempt to minimize the dissolution of these metals by using gentle bicarbonate solutions.

In contrast to the U.S. requirements, in Kazakhstan, groundwater is not restored, as Kazakh requirements allow the contaminants in the groundwater to precipitate or dilute under natural processes with no active efforts to restore the water quality. Natural attenuation requires little energy or manpower and is therefore very inexpensive.

Another cost advantage of using sulfuric acid is that the solution head grades in Kazakhstan are commonly 100 percent higher than those at ISR mines in the U.S. This dramatically shortens the time to recover the uranium in the orebody, which in turn reduces the operating cost and allows production to respond quickly to improvements in the market.

While Kazakh uranium is produced primarily in the Tenge, it is sold in dollars. This has had the effect of making Kazakh uranium 87 percent cheaper in the U.S. market. The chart below illustrates the dramatic decline in the value of the Kazakh Tenge that has provided Kazakh producers with a significant price advantage to the detriment of U.S. miners.



China
China is using subsidiaries of its state-owned nuclear companies, China National Nuclear Corporation ("CNNC") and China General Nuclear ("CGN") to invest heavily in foreign uranium projects, intended to secure production sources that feed China's growing nuclear power industry and possibly to begin exporting their products and technology globally. China is acquiring uranium deposits in Africa, as part of their "Belt and Road Initiative." in Africa.

For example, the Husab mine in Namibia, owned by CGN, is expected to significantly increase production in 2019, despite having all-in costs of just below $50 per pound, or significantly higher than today's spot and long-term uranium prices ($25 per pound and $32 per pound, respectively).[29]

Despite the cost of production at Husab being significantly higher than either spot or term market prices, the Chinese government has continued to ramp up mine production. This new price-insensitive Namibian/Chinese production will offset reductions from other international sources and add to the pressure on U.S. miners.

To further strengthen Chinese control of Namibian government. The Rossing mine has been a supplier of free-market uranium since the 1970's, and that production will now be controlled by the Chinese government.[30] Furthermore, Chinese state-owned entities acquired this mine, and they intend to continue production despite costs estimated to be nearly $75 per pound.[31]

At the same time, the Chinese entity has agreed to construct the new headquarters for the Namibian ruling party (SWAPO) at the cost of USD$51 million, in exchange for receiving four Exclusive Prospecting Licenses from the Namibian government. Not surprisingly, these types of transactions are prohibited by U.S. law.[32]

As with the rare earths industry, China is strategically acquiring uranium resources and removing them from access by the free world. China is utilizing its "Belt and Road Initiative" not only to gain access to African nations governments, but also to control strategic minerals, including uranium.

China is also constructing enrichment capacity well in excess of its current or future requirements. As discussed above under the "Russia" section. China probably desires to expand its nuclear fuel footprint, partially as a result of their enrichment capabilities. In fact, in 2014 and 2015, "multiple U.S. utilities signed contracts with Chinese companies for enrichment services."[33]

The Chinese companies subsequent failure to deliver was an indication that their industry was in its infancy at the time. However in 2015, the World Nuclear Association estimated that China had enrichment capacity of 5.7–7.0 million SWU (separative work units), and they project that by 2020 China is expected to have enrichment capacity of 10.7–12.0 million SWU versus demand of approximately 8 million SWU. This indicates an intent to export enrichment that directly competes with uranium mining.

Strategic Importance Of Reviving Domestic Uranium Production

Energy Fuels is the U.S.' largest uranium miner. The following discussion is from an Energy Fuels Inc. detailed description of uranium infrastructure and what it would take to rebuild required uranium facilities "from scratch" in the future in terms of money and time.

<u>**Conventional Uranium Mines**</u>

What is a Conventional Uranium Mine?

A conventional uranium mine is an open pit or underground mine that produces uranium ore. That ore is then sent to a conventional uranium mill for processing into usable U_3O_8. In order to produce uranium using conventional techniques, you need both a conventional mill and conventional mines that feed ore to the mill.

Existing Conventional Uranium Mines in the U.S.

The U.S. has a number of conventional uranium mines. Some like underground La Sal Complex in southeast Utah and Canyon Mine in northern Arizona are fully-permitted and developed. Others like Energy Fuels' Sheep Mountain Project in central Wyoming is fully permitted as an open pit mine; however, there is no processing facility nearby to process the ore (except Kennecott's Sweetwater Mill, which is currently slated for reclamation pending a positive outcome in the Uranium 232 process).

Other mines like Energy Fuels' large Roca Honda Project in northwest New Mexico is undeveloped and in the process of being permitted (it is in year eight (8), of what is expected to be a ten (10) year EIS process).

Below is a list of fully-licensed conventional uranium projects currently on standby which could go into production, with the appropriate market signals, within a relatively short period of time following a production start decision:

• Canyon Mine (Arizona) – fully-permitted and developed; extensive installed surface and underground development; could go into production within about 6 – 12 months.
• La Sal Complex (Utah) – fully-permitted and developed series of interconnected underground uranium and vanadium mines along a ten (10) mile mineral trend; extensive installed and underground development; could go into production within about 6 months.

• Mount Taylor Mine (New Mexico) – fully-permitted and partially-developed large mine; extensive existing surface and underground development; could go into production within about 24 months.

• Daneros Mine (Utah) – fully-permitted and partially-developed mine; extensive installed surface and underground development; could go into production within about 12 months.

• Tony M Mine (Utah) – fully-permitted and partially-developed mine; extensive installed surface and underground development; could go into production within about 12 months

• Whirlwind Mine (Colorado) – fully-permitted and partially-developed uranium and vanadium mine; extensive surface and underground development; could go into production within about 12 months.

• Rim Mine (Utah) – fully-permitted and undeveloped uranium and vanadium mine; could go into production within about 18 months.

• Sunday Complex (Colorado) – fully-permitted and partially developed uranium and vanadium mine; could go into production within about 12 months. Arizona 1 Mine (Arizona) – fully-permitted and partially-developed mine; could go into production within about 12 months.

Below is a list of large conventional uranium projects that are currently in licensing and permitting:

• Roca Honda Project (New Mexico) – advanced stage of permitting with EIS expected to be completed in 2021.

• Sheep Mountain Project (Wyoming) – the mine is fully-permitted for production; however, no mill or processing facility has been identified to process the ore. Options include utilizing the nearby Sweetwater Mill (owned by Kennecott Uranium, who has indicated that they intend to reclaim the site) or to license and permit a small mill or heap leach facility, the permitting for which is expected to take between 5–7 years to complete.

• Bullfrog Project (Utah) – Energy Fuels is currently in the pre-permitting stage.

There are a number of other conventional uranium projects and deposits in the U.S., owned by Energy Fuels and others, located primarily in Utah, Colorado, New Mexico, Arizona, and Wyoming, that could enter production within the next 4–8 years, depending on market signals.

Conventional Uranium Mines Replacement Cost: $1.47 billion total

Nine fully-permitted conventional uranium mines on standby. Seven of these mines are owned by Energy Fuels, of which two (Canyon Mine and La Sal Complex) were recently estimated to have a combined replacement cost of approximately $98 million, and which require a combined $40 million to bring into full production.

We conservatively estimate that the other five (Daneros, Tony M, Whirlwind, Rim, and Arizona 1) have replacement costs of $30 million each ($150 million total), and which require a combined $50 million to bring into operational status. This equals a total replacement value of these seven (7) mines of $238 million.

The other two conventional mines are not owned by Energy Fuels. We estimate that the Mount Taylor Mine, a large, high-grade mine owned by General Atomics in New Mexico, has a replacement cost of approximately $300 million, along with a requirement of $100 million to bring into operational status. We estimate that the Sunday Complex in Colorado, a series of underground uranium/vanadium mines, similar to our La Sal Complex and owned by Western Uranium, has a replacement cost of $30 million, and requires about $10 million to bring into operational status. This equals a total replacement value of $440 million for these two mines.

Three large conventional uranium mines in various phases of development & licensing. These three are all owned by Energy Fuels, and the Company recently estimated their replacement cost at existing status to be a combined $244 million. We estimate that it would cost another $350 million to bring these three (3) conventional projects into operational status, for a combined total of $594 million.

Several conventional uranium deposits in various phases of development & licensing. These properties also hold considerable value; however estimating replacement costs for purposes of this paper is difficult. However, we estimate a total replacement value of $200 million.

Conventional Uranium Mines Replacement Time: 8-10 years

The time we estimate that a new uranium mine could be licensed and constructed in the U.S., based on recent experience is 8-10 years.

The EIA does not describe any conventional uranium mines as a part of their annual report. The mines described in this white paper are based on the internal company knowledge.

ISR Uranium Recovery Facilities

What is ISR?

In-situ recovery ("ISR") is a method of uranium mining that uses leaching solution to extract uranium from certain sandstone hosted uranium deposits. The leaching agent, which contains an oxidant such as oxygen with sodium bicarbonate (commonly known as baking soda) and carbon dioxide, is added to the exiting groundwater and injected through wells into the ore body in a confined aquifer to dissolve the uranium. This solution is then pumped via recovery wells to the surface for processing in an ISR processing plant. Most recently, ISR mining has occurred in the U.S. in Wyoming, Texas, and Nebraska.

Uranium recovery using ISR functions differently from a conventional uranium mine and mill configuration. Because there is no need to go underground or strip an open pit to access the deposit, the surface impacts are limited to the discreet well locations and surface processing facilities. The surface processing facilities required to process the uranium rich solutions near the orebody are the equivalent footprint of a small conventional uranium mill receiving ore directly from a conventional mine. But, in ISR no ore is moved. In some cases, small ore bodies can be mined using ISR techniques using a partial processing plant, called a remote IX.

In-situ recovery wellfields typically contain 100 or more injection and production wells. Like in oil and gas wells, production is usually higher in the early periods of operation and then go into decline. In ISR uranium wellfields, the highest levels of production occur during Year 1 of operation and quickly decline thereafter. Therefore, in order to maintain production, one must continually install new wellfields to keep the project from going into decline.

Existing ISR Plants and Mines in the U.S.

According to the EIA, the U.S. currently has five fully-licensed operating in-situ recovery ("ISR") facilities; four fully-licensed ISR facilities on standby; and six ISR facilities in various phases of licensing and development.

The five (5) operating ISR facilities include:

- Nichols Ranch (Wyoming) – Energy Fuels
- Lost Creek (Wyoming) – Ur-Energy
- Lance (Wyoming) – Peninsula Energy
- Smith Ranch-Highland (Wyoming) – Cameco
- Crow Butte (Nebraska) - Cameco

None of these projects have installed new wellfields over the past few years due to depressed uranium prices. Therefore, all of these projects are well down their decline curves. Energy Fuels estimates that all of these projects will have reached the point where the value of production does not exceed the cost of operating by 2020; thereby necessitating a cold shutdown for these projects. Cameco's projects (Smith Ranch-Highland and Crow Butte) reached those points in 2016; however, Cameco continues to operate these facilities for groundwater restoration purposes.

The four ISR projects on standby include:
• Alta Mesa (Texas) – Energy Fuels
• Hobson (Texas) – Uranium Energy Corp.
• La Palangana (Texas) – Uranium Energy Corp.
• Willow Creek (Wyoming) – Uranium One

The six ISR facilities that are licensed but not constructed, include:
• Reno Creek (Wyoming) – Uranium Energy Corp.
• Dewey Burdock (South Dakota) – Azarga Uranium
• Churchrock (New Mexico) – Laramide Resources
• Crownpoint (New Mexico) – Laramide Resources
• Goliad (Texas) – Uranium Energy Corp.
• Moore Ranch (Wyoming) – Uranium One

In-Situ Recovery ("ISR") Plants and Mines Replacement Cost: $810 million total
Of five fully-licensed operating in-situ recovery ("ISR") facilities (of which two are currently operating only for groundwater restoration purposes), two are owned by Energy Fuels. The Company recently estimated a replacement cost of a combined $100 million. The Company believes it would cost an additional combined $20 million each to bring these two projects into sustainable production, implying a cost of $140 million total.

Conservatively attributing a $50 million replacement cost to the other three facilities, and $20 million each of investment to bring them into sustainable production, equals $210 million of cost. Four fully-licensed ISR facilities on standby. The Company conservatively estimates that these assets could be valued at one-half of the value of a fully-constructed ISR facility; $25 million each or $100 million total. To bring these facilities into production, the Company estimates that it would cost approximately $40 million per facility, or a total cost of $260 million.

Several ISR facilities and projects in various phases of development and licensing. These properties also hold considerable value; however estimating values for purposes of this paper is difficult. For purposes of this white paper, we will attribute a total replacement value of $200 million.

Conventional In-Situ Recovery Plants and Mines Replacement Time: 8-12 years
The time we estimate that a new ISR plant and mine could be licensed and constructed in the U.S., based on recent experience is 8-12 years.

<u>**Conventional Uranium Mills**</u>

What is a Conventional Uranium Mill?
A conventional uranium mill is a facility that processes conventional uranium ore produced at a conventional uranium mine into natural uranium concentrates (U_3O_8, or "yellowcake"), and disposes of the resulting waste in tailings impoundments. Uranium ore (rock containing recoverable quantities of uranium) is produced in underground or open pit mines and shipped to a mill where it is processed for the recovery of U_3O_8. A conventional uranium mine needs a conventional mill, and is useless without one.

Existing Conventional Uranium Mills in the U.S.
At the current time, the US has only one (1) operating (or even operational) conventional uranium mill, the White Mesa Mill owned by Energy Fuels. The White Mesa Mill is a fully-licensed and currently operating facility in good standing, located on about 5,000-acres of fee land near the town of Blanding, Utah.

The White Mesa Mill has a throughput capacity of 2,000 tons per day and a licensed capacity of approximately 8 million pounds of U_3O_8 per year. In addition to being the only operating conventional uranium mill in the US, the White Mesa Mill is also strategic as it is the only facility in the US licensed and capable of:

Processing conventional ore for the recovery of vanadium (another critical mineral); and recycling "alternate feed materials," which are materials not derived from conventional uranium mining (often material streams from the uranium conversion process and byproduct streams from rare earth element processing facilities) that contain recoverable quantities of a natural uranium. The White Mesa Mill has also participated in U.S. government-run cleanups of Cold War era uranium facilities.

The White Mesa Mill has produced an average of about one million pounds of U_3O_8 per year for the past several years. However, it is very under-utilized, as it has a licensed capacity to produce over eight million pounds of U_3O_8 per year. The White Mesa Mill is comprised of mill facilities (ore pad, grinder, leach tanks, solvent extraction, CCD, drying and packaging), a vanadium circuit, a separate alternate feed materials processing circuit, and state-of-the-art tailings management facilities that utilize double-lined synthetic liners with leak detection and a third geo-synthetic clay liner.

The White Mesa Mill's current footprint (including mill facilities and existing tailings) is about 500 acres; therefore, there is considerable room to build many more tailings facilities well into the future.

There are also two existing conventional uranium mills in the U.S. that are currently on standby: the Sweetwater Mill (Wyoming) and the Shootaring Canyon Mill (Utah). These two facilities have existing Radioactive Material Licenses, but they are not currently in operation, nor are they operational at this 1,432-acre site consists of a mill area (a uranium mill building, a solvent extraction building, an administrative building, and a maintenance shop), ore pad, and 60-acre tailings impoundment.

The Sweetwater facility has a throughput capacity of 3,000 tons of ore per day and it operated from 1981–1983. It has been maintained in good condition on standby status since that time. This 1,432-acre site consists of a mill area (a uranium mill building, a solvent extraction building, an administrative building, and a maintenance shop), an ore pad, and a 60 acre tailings impoundment.

In 2016, Rio Tinto announced that it intended to reclaim the Sweetwater Mill, however, it is our belief that the reclamation decision was deferred pending a decision on the Uranium 232 process time. The Sweetwater Mill is located in central Wyoming, and is owned by Kennecott Uranium (a subsidiary of Rio Tinto).

The Shootaring Canyon Mill is located in southeast Utah near the town of Ticaboo, and is owned by Anfield Energy. This 1,000 ton per day facility commenced operations in1982 and operated for about six months. Since 1982, it has been on care and maintenance.

Conventional Uranium Mills Replacement Cost: $1.42 billion total
White Mesa is the only fully-licensed operating conventional uranium mill. Energy Fuels recently estimated that the replacement cost of the White Mesa Mill (a 2,000 ton per day) is approximately $485 million. This facility is also the only existing conventional vanadium mill in the U.S., and has a separate vanadium circuit; vanadium is another mineral critical to the national security of the U.S.

This facility is the only facility in the U.S. that can recycle “alternate feed materials”, which are uranium-bearing materials that are not derived from conventional mining (often waste-streams). The White Mesa Mill worked with North American uranium conversion facilities on various cleanup projects, and the U.S. government in the cleanup of former Cold War era uranium facilities. White Mesa has a separate alternate feed materials circuit.

Two fully-licensed conventional uranium mills are on standby. The estimated cost to replace the Sweetwater Mill in Wyoming (a 3,000 ton per day facility) into operational status would be approximately $618 million. It is also estimated that the cost to replace the Shootaring Canyon Mill in Utah (a 1,000 ton per day facility) into operational status would be $321 million.

The estimated time that a new uranium mill could be licensed and constructed in the US, based on recent experience is 12-20 years.

Disparity Between U.S. vs. State-Owned Uranium Companies

The following summarizes a few of the advantages that state-owned entities enjoy over U.S. companies:

• **Use of Government Assets**: The governments of Russia, Kazakhstan, Uzbekistan, China and others provide their state-owned entities with the unrestricted use of various mining and enrichment facilities, much of which was developed by the Soviet Union during the Cold War era. U.S. miners must use their own financial resources to develop and construct these assets.

For instance, Russia’s state-owned company, Rosatom, through its direct and indirect ownership of mines in Kazakhstan, along with their ability to use of nationally-owned Cold War era mining, conversion and enrichment infrastructure, is able to bundle uranium, conversion, and enrichment into a single product, enriched uranium product (“EUP”), that is offered to U.S. nuclear utilities at a significant discount that cannot be matched by free-marketentities. Bundled EUP competes directly with uranium mining.

• **Free Data & Technical Support**: The governments of Russia, Kazakhstan, Uzbekistan, China and others provide their state-owned mining entities with access to significant data and technical expertise, much of which was developed by the Soviet Union during the Cold War era. U.S. miners must develop this data and expertise using their own financial resources.

• **Currency Devaluation**: Imports from Kazakhstan have recently benefited from an 87 percent devaluation of the national currency in comparison to the U.S. dollar. Imports of enrichment services and EUP from Russia have benefitted 61 percent devaluation of the Ruble against the U.S. dollar over the same period of time.

• **State-Owned Mineral Ownership**: The governments of Russia, Kazakhstan, Uzbekistan and China are the owner of the land and mineral deposits. Therefore, the miner and the mineral owner are essentially the same entity, working in concert toward the common government goals. U.S. miners must manage a patchwork of land and minerals owned by federal, state, and private entities, who's goals often do not align, and in many cases, will result in burdensome royalties, acquisition costs, and leasehold maintenance costs.

• **State-Owned Vendors**: The governments of Russia, Kazakhstan, Uzbekistan and China are the owners of major goods and services providers to their mines, providing these assets at significant discounts and creating jobs; from drilling contractors to acid suppliers to caterers. U.S. miners must compete for goods and services that are specialized for the industry.

• **Government Regulators**: Russia, Kazakhstan, Uzbekistan, China and elsewhere have minimal laws and regulations covering worker safety, human health and environmental protection. Furthermore, the miner and the regulator both government entities, and therefore work toward their nations' common goals. Enforcement of regulations (to the extent they exist) is minimal. The U.S. uranium mining industry is required to meet much higher standards and compliance is very costly and time-consuming.

• **Government Courts**: The U.S. uranium mining industry endures extensive legal challenges, more than anywhere else in the word, from activist groups and non-governmental organizations (NGO's). Defending these suits is expensive and time consuming. Since the miner and the court are both government entities in Russia, Kazakhstan, Uzbekistan and China, state-owned entities in these nations do not incur these significant costs and delays.

• **No Requirement to Provide Return on Investment**: The companies that comprise the U.S. nuclear fuel industry are publicly and privately owned. Their ability to compete is dependent on a free and fair global market that will provide a fair rate-of-return for their shareholders and owners. If shareholders and owners do not see a potential for a rate-of-return, they will not deploy the capital needed to support these companies. Existing companies will disappear, and no new companies will come into being.

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