# “Regional cooperation in uranium field”

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**Abstract:** World countries are reducing their energy production source of coal, crude oil and natural gas and are proceeding to generate power with nuclear energy and renewable energy. In this situation, regional cooperation, including cooperation of Russia, China, Kazakhstan and Mongolia, on uranium is becoming a more important factor. Nuclear energy causes minimum damage to the environment and is a cost-effective technology. Uranium is the main source of nuclear energy production. China has been working intensively in favor of nuclear energy to meet its growing energy needs increase. In the case of Mongolia, Mongolia has nearly 130 thousand-uranium reserves and is placed 16th on highest uranium reserves in the world and 6th in Asia. Mongolia should to pay special attention to China’s energy policy, and adoption of Russian advanced technology.

***Keywords:Uranuim, regional cooperation in uranium field***



***One. General background of world uranium resource and extraction.*** Peaceful usage of nuclear power is becoming indivertibly a key factor in world development. The key element for this is uranium, which is comparatively wide spread around the world.

Growth of population and economy, depletion of natural resources, climate change, and energy security all are adding up to the tendency of interest for nuclear energy. Current climate change is the biggest effect of the hyper fast industrialization that took place in the last few decades. The main weapon to combat climate change is renewable energy. Nuclear energy’s production as a renewable energy has minimal negative effect on the environment, as such nuclear energy has been declared as an integral part of world energy production[1]. Researchers predicted the world population will reach 8.1 billion by 2020 and energy consumption of individuals will increase 2.8 times in comparison to those of 1990. Increase in energy demand is resulting a surge in quest of safer and cheaper energy sources, extraction and production of energy resources, including nuclear energy and uranium issues. As energy is the basis and driving force of modern economy, countries are pursuing individual strategies with increased emphasis on the region policies.

**Northeast Asia’s energy usage pattern**

[1]Friends of the Earth and Greenpeace

**(Pattern until 2020)**

**Table №1**

| | Periods compared | | | | Average increase | |
|---|---|---|---|---|---|---|
| | **2004** | **2010** | **2015** | **2020** | **2004-2010** | **2010-2020** |
| **Coal** | 1 274 | 1 499 | 1 803 | 2 172 | 3,6% | 3,8% |
| **Oil** | 868 | 970 | 1 094 | 1 218 | 1,9% | 2,3% |
| **Natural Gas** | 465 | 539 | 629 | 750 | 2,5% | 3,4% |
| **Nuclear energy** | 132 | 164 | 200 | 240 | 3,7% | 3,9% |
| **Water energy** | 114 | 149 | 188 | 238 | 4,6% | 4,8% |
| **Renewable energy** | 21 | 30 | 40 | 54 | 6,1% | 6,1% |
| **Total** | **2 814** | **3 352** | **3 954** | **4 673** | **3,0%** | **3,4%** |

Source: http;//world-nuclear.org/info/Country-Profiles/Countries-G-N/Namibia

As energy is the basis and driving force of modern economy, countries are pursuing individual strategies with increased regionalization of policies. According to the “Red Book” published in 2014, world’s total uranium resource is 5.9 million tons, which is 10.8 percent increase from previous year’s estimates. Uranium demand in nuclear power plants was estimated around 66.9 thousand tons in 2015, and the demand is growing as number of nuclear power plants increase.



**The world’s proven reserves of uranium**

**Table №2**

| № | The name | Uranuim, tonn | Proportion |
|---|---|---|---|
| 1. | Australia | 1.706.100 | 29% |
| 2. | Kazakhstan | 679.300 | 12% |
| 3. | Russia | 505.900 | 9% |
| 4. | Canada | 493.900 | 8% |
| 5. | Nigeria | 404.900 | 7% |
| 6. | Namibia | 382.800 | 6% |
| 7. | South Africa | 338.100 | 6% |
| 8. | Brasil | 276.100 | 5% |
| 9. | USA | 207.400 | 4% |
| 10. | China | 199.100 | 4% |
| 11. | Mongolia | 141.500 | 2% |
| 12. | Ukraine | 117.700 | 2% |
| 13. | Uzbekhstan | 91.300 | 2% |
| 14. | Botsban | 68.800 | 1% |
| 15. | Tanzani | 58.500 | 1% |
| 16. | Yordan | 40.000 | 1% |

| | | | |
|---|---|---|---|
| 17. | **Other** | **191.500** | **3%** |
| 18. | **Total** | **5.902.900** | |

Source:http;//world-nuclear.org

As of 2014, over 56.2 thousand tons of uranium are extracted globally of which 23.1 thousand tons are extracted from Kazakhstan alone, putting Kazakhstan at the top of global uranium extraction. Global uranium extraction is divided into Kazakhstan with 41 percent, Canada with 16 percent and Australia with 9 percent respectively.

**2006-2013's uranium production of world's leading uranium producing countries (tonnes)**

**Table №3**

| № | Country | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Kazakhstan | 5279 | 6637 | 8521 | 14020 | 17803 | 19451 | 21317 | 22451 |
| 2 | Canada | 9862 | 9476 | 9000 | 10173 | 9783 | 9145 | 8999 | 9331 |
| 3 | Australia | 7593 | 8611 | 8430 | 7982 | 5900 | 5983 | 6991 | 6350 |
| 4 | Nigeria | 3434 | 3153 | 3032 | 3243 | 4198 | 4351 | 4667 | 4518 |
| 5 | Namibia | 3067 | 2879 | 4366 | 4626 | 4496 | 3258 | 4495 | 4323 |
| 6 | Russia | 3262 | 3413 | 3521 | 3564 | 3562 | 2993 | 2872 | 3135 |
| 7 | Uzbekhstan | 2260 | 2320 | 2338 | 2429 | 2400 | 2500 | 2500 | 2400 |
| 8 | USA | 1672 | 1654 | 1430 | 1453 | 1660 | 1537 | 1596 | 1792 |
| 9 | China | 750 | 712 | 769 | 750 | 827 | 885 | 1500 | 1500 |
| 10 | Malaвi | | | | 104 | 670 | 846 | 1101 | 1132 |
| 11 | Ukraine | 800 | 846 | 800 | 840 | 850 | 890 | 960 | 922 |
| 12 | South Africa | 534 | 539 | 655 | 563 | 583 | 582 | 465 | 631 |
| 13 | India | 177 | 270 | 271 | 290 | 400 | 400 | 385 | 385 |
| 14 | Brasil | 190 | 299 | 330 | 345 | 148 | 265 | 231 | 231 |
| 15 | Czech Republic | 359 | 306 | 263 | 258 | 254 | 229 | 228 | 215 |
| 16 | Romania | 90 | 77 | 77 | 75 | 77 | 77 | 90 | 77 |
| 17 | Pakistan | 45 | 45 | 45 | 50 | 45 | 45 | 45 | 45 |
| 18 | Germany | 65 | 41 | 0 | 0 | 8 | 51 | 50 | 27 |
| 19 | France | 5 | 4 | 5 | 8 | 7 | 6 | 3 | 5 |
| 20 | **Total** | **39444** | **41282** | **43764** | **50772** | **53671** | **53493** | **58394** | **59370** |
| | % compared to world's total production of Uranium | 63% | 64% | 68% | 78% | 78% | 85% | 86% | 92% |

Source:http;//world-nuclear.org/info/Country-Profiles/Countries-G-N/Namibia

New methods of uranium extraction are introduced along with advancements in science and technology. As of 2014, underground mining takes 51 percent of total extraction of uranium and over 95 percent of Kazakhstan uranium mining is using this method. Nine companies produced 88 percent of total uranium mining in 2014.

**2014 Leading uranium exploration company**

**Table №4**

| № | Company name | Amount of uranium, tonn | Proportion% |
|---|---|---|---|
| 1. | Kazatomprom | 13.801 | 25 |
| 2. | Kamyenko | 8.956 | 16 |
| 3. | APMZ | 6.944 | 12 |
| 4. | Areva | 6.496 | 12 |
| 5. | BHP Billiton | 3.351 | 6 |
| 6. | CNNC&CGN | 2.684 | 5 |
| 7. | Paladin | 2.316 | 4 |
| 8. | Navoi | 2.400 | 4 |
| 9. | Rio Tinto | 2.296 | 4 |
| 10. | **Other** | **6.973** | **12** |
| 11. | **Total** | **56.217** | **100** |

Source:http;//world-nuclear.org/info/Country-Profiles/Countries-G-N/Namibia

Around 16 percent of world energy is produced by nuclear power. Currently, enriched uranium is used in nuclear power plants and nuclear reactors of vehicles. Due to constant decrease of natural energy resources such as coal, gas and oil, nuclear energy is rising as a solid alternative. Currently over 436 nuclear power plants are active around the world with 104 in USA, 58 in France, 33 in Russia and 17 in China. Most of the 66 nuclear plants in construction are located in Asia.



**Table №5**

| Country | In operation | | Under construction | |
|---|---|---|---|---|
| | Number | Electr. net output MW | Number | Electr. net output MW |
| Argentina | 3 | 1,627 | 1 | 25 |
| Armenia | 1 | 375 | - | - |
| Belarus | - | - | 2 | 2.218 |
| Belgium | 7 | 5,913 | - | - |
| Brazil | 2 | 1,884 | 1 | 1,245 |
| Bulgaria | 2 | 1,926 | - | - |
| Canada | 19 | 13,500 | - | - |
| China | 31 | 26,635 | 24 | 24,128 |
| Czech Republic | 6 | 3,904 | - | - |
| Finland | 4 | 2,752 | 1 | 1,600 |
| France | 58 | 63,130 | 1 | 1,630 |
| Germany | 8 | 10,799 | - | - |
| Hungary | 4 | 1,889 | - | - |
| India | 21 | 5,308 | 6 | 3,907 |
| Iran | 1 | 915 | - | - |
| Japan | 43 | 40,290 | 2 | 2.650 |
| Korea, Republic | 25 | 23,117 | 3 | 4,020 |
| Mexico | 2 | 1,440 | - | - |
| Netherlands | 1 | 482 | - | - |
| Pakistan | 3 | 690 | 2 | 630 |
| Romania | 2 | 1,300 | - | - |
| Russian Federation | 35 | 25,443 | 8 | 6,582 |

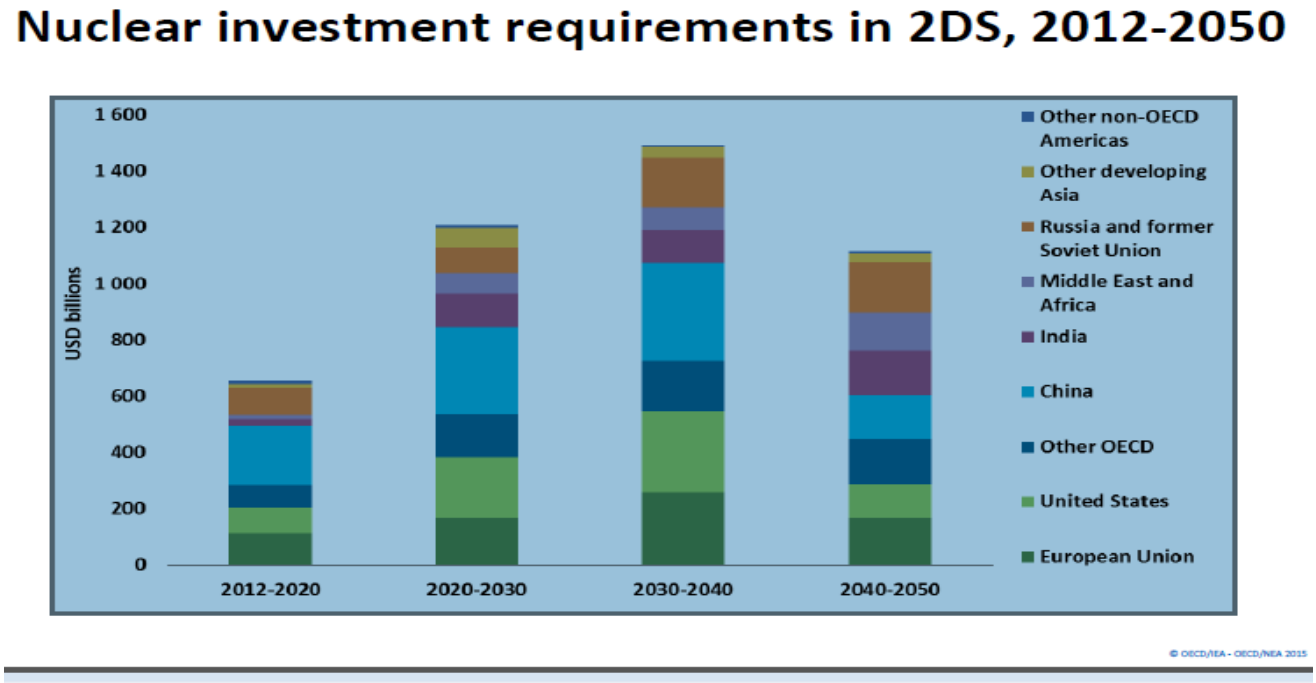
| | | | | |
|---|---|---|---|---|
| Slovakian Republic | 4 | 1,814 | 2 | 880 |
| Slovenia | 1 | 688 | - | - |
| South Africa | 2 | 1,860 | | |
| Spain | 7 | 7,121 | | |
| Sweden | 10 | 9,648 | | |
| Swetzirland | 6 | 3,333 | | |
| Taiwan, China | 5 | 5,032 | 2 | 2,600 |
| Ukraine | 15 | 13,107 | 2 | 1,900 |
| United Arab Emirates | - | - | 4 | 5,380 |
| United Kingdom | 15 | 8,883 | - | - |
| USA | 99 | 98,178 | 5 | 5,633 |
| Total | 442 | 383,513 | 66 | 65,02 |

Source:http;//world-nuclear.org/info/Country-Profiles/Countries-G-N/Namibia

Since the Fukushima disaster of 2011, a total of 24 countries, including USA, the Emirates, Argentina, Belarus, ROK, India, Pakistan, Russia, China and Brazil, have started construction of new nuclear reactors. Also 6 more reactors are planned to be built in India, 5 more in USA, 9 more in Japan and 8 more in Korea[2].

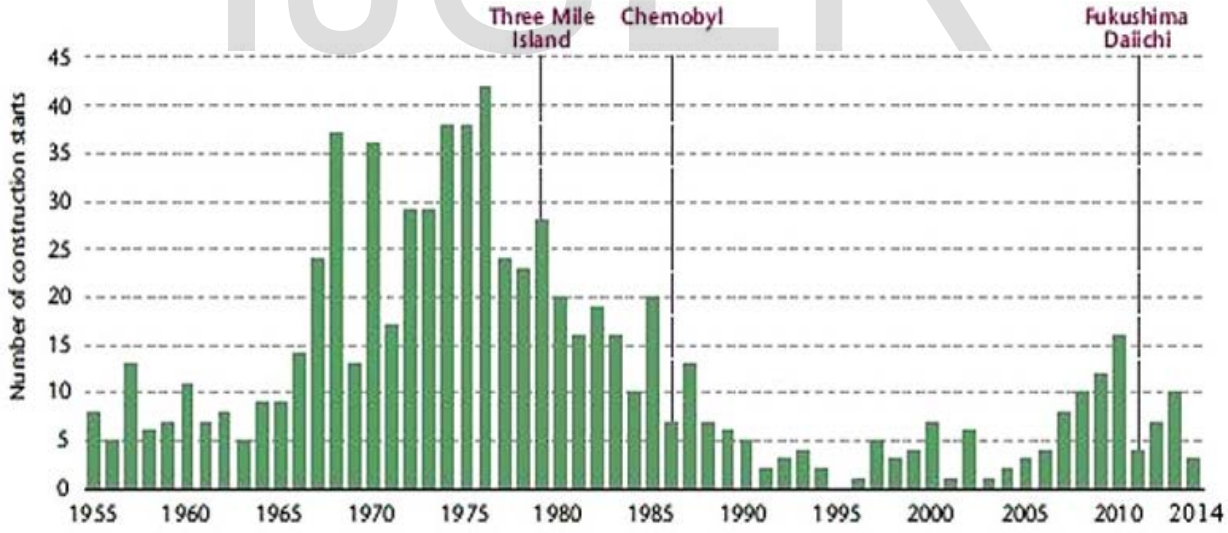
The world nuclear energy agency reports that combined capacity of nuclear energy amounted to 371.1GW in 2012, 377GW in 2014 and it is expected to grow to 650GW by 2030 and 930GW by 2050[3]. Moreover, world nuclear energy demand is expected to grow by 23 to 100 percent by the year 2030.

[2]Nuclear reactor database of International Atomic Energy Agency
[3]Nuclear Energy Agency




**Number of Nuclear Energy reactors built during 1955 – 2014**

Figure №1

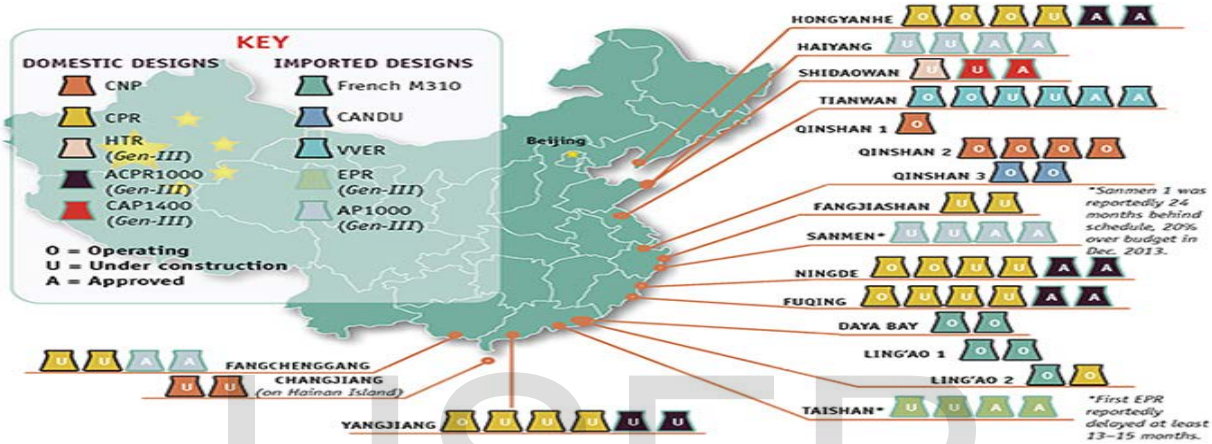



***Two. China-Russian cooperation on Uranium:*** China is expressing great interest in nuclear energy in order to supply its ever-increasing energy demand. It is one of the five countries that received nuclear technology from Soviet Union. China built its first nuclear power plant in 1970 and as of 2015, it operates 31 nuclear reactors with a combined capacity of 170.355GW. China also planned 43 more new reactors and intends to increase the number by 136 more reactors in the

future, which would increase their nuclear energy production 4 times. Moreover, It plans to increase the installed capacity of nuclear power plants to 58GW in 2020, 200GW in 2030 and 400GW in 2050 with nuclear power plants established along its coastline. The current reactors are using CRP-1000 model and China intends to introduce modern AP-1000 model reactors starting from 2020**.**

**Currently active nuclear reactors**

Figure №2

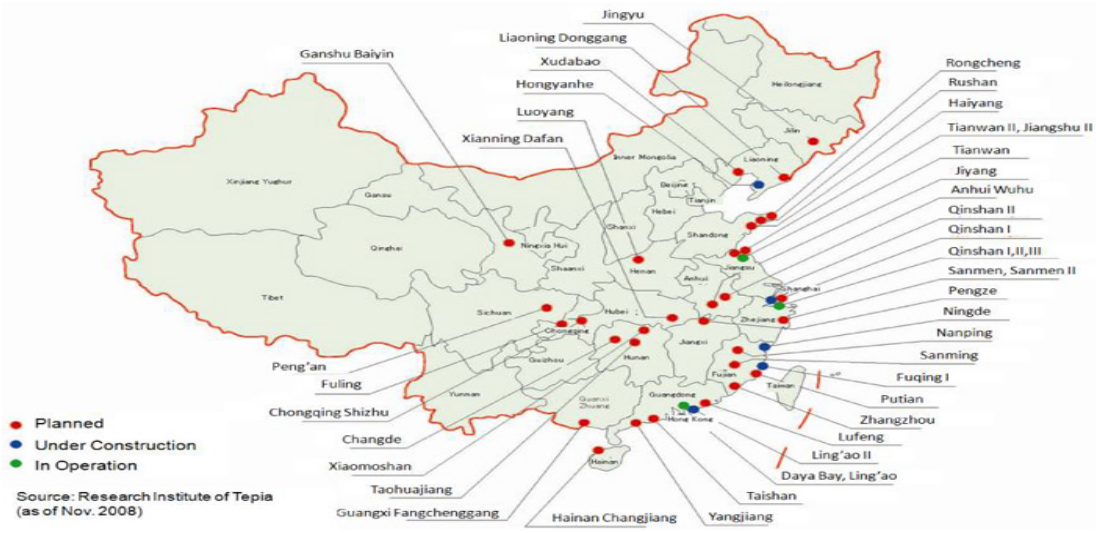



Source:http;//world-nuclear.org/

In 2012, China shocked the world with a new technology of extracting uranium and plutonium from used nuclear fuels. Thanks to this new technology, efficiency of nuclear energy increased by 60 percent, thus opened a new stage of more efficient and safer nuclear development possibility for nuclear reactors.

## Locations of China's Nuclear Power Plants

Figure №3




According to Chinese economic development program, 101 nuclear blocks will be built 2015-2030 and investment of 1.2 trillion yuan or 196 billion dollars is planned. The country pays great attention and invests a lot in acquisition and supply of uranium for these nuclear power plants. All the uranium related issues are operated by a single state owned company (CNNC covers Northern China and CGNPHC covers Southern China).

China is a major importer of uranium. Uranium deposits in China have low concentrate and are located very deep, thus resulting China to import large quantity of uranium from Kazakhstan, Uzbekistan, Canada, Nigeria, Namibia and Australia. In 2012, China imported 12,909 tons of uranium; in 2013, China imported 18,968 tons of uranium; and in 2013 China bought 80 percent of total uranium mined by Kazakhstan[4]. Moreover, CNNC signed a contract with Canadian "Camero Corp Company" on buying uranium worth of 29 million pounds until 2025.

In order to acquire uranium, in 2012 China spent 1.731 billion dollars in buying uranium when one pound of uranium was priced 51.58 dollars. In 2013, it spent 2.371 billion dollars in buying uranium when one pound of uranium was priced 48.09 dollars. Chinese experts predict that consumption of uranium will reach 20-25 thousand tons by 2020, and this is becoming the main reason of China creating its own uranium reserve. Currently Chinese uranium resource is measured as 48,800 tons and the average annual demand is being 9814-10340 tons. The country is working hard to increase the reserve. Uranium deposits within PRC are located in Zhuungar-Tiangshang of Shinjiang region, Erliang of Inner Mongolian region, Yungshiang Liahou of North

[4]G.Jamsrandorj, G,Dejidmaa, G.Ukhnaa. "Uranium". 2015

East China, Ordos of Central China, and Qilliang Quilin and Western Yunnan of Southern China regions.

Energy demand in China is predicted to grow to 6.27 billion KW by the end of 2015 and 8.2 billion KW by 2020, thus increasing two folds comparing to level in 2010[5]. Currently 60 percent of energy is produced from coal, 20 percent from oil and the rest from nuclear energy. Recently China is aiming to change its coal dominated energy system, this is especially included in the 13th five year plan with composition changed to 63 percent from coal, 17.1 percent from oil, 9 percent from hydro and nuclear sources, 8.3 percent from natural gas and 2.6 percent from renewable sources by 2016-2020[6].

China has been actively increasing and broadening international cooperation and relations in the field of nuclear energy and natural resources. It is giving importance to the first stage of nuclear fuel cycle, uranium exploration, mining and initiating cooperation with international uranium projects. Within the Chinese CNNC, SinoUranium Corporation is cooperating with Kazakhstan, Uzbekistan, Namibia, Mongolia, Algeria, Canada and South Africa. As of 2014, SinoUranium bought 10 percent of Azelik mine in Nigeria and made investment of 200 million euro. It also bought 57 thousand tons from Langer Heinhich mine of Paladine and made investment of 190 million dollars[7]. At the end of 2015, China started new stages of cooperation and investment with United Kingdom, Czech Republic, Romania, Argentina, Slovakia, Kazakhstan and South Africa in the nuclear energy and nuclear fuel sector.



There are 35 nuclear reactors operating in Russia, producing 213600GW (which is 18.57 percent of total energy production of Russia) and 8 new reactors are under construction. In the future, the country planned to build 31 reactors and intends to construct 18, and plans to increase nuclear energy production by 23 percent in 2020 and by 25 percent in 2030.

## Russian Nuclear Reactor Plans

Figure №4

[5]PRC's energy demand, Sino-Mongolian cooperation on mining, page 8. 2013
Institute for Strategic Studies of Mongolia
[6]http;//www.mongolian mining journal.com/content/48160.shtml
[7]Word Nuclear Association News Briefing


Nuclear energy and uranium related issues of the country are operated by the state owned Rosatom Company, which controls 40 percent of world's total enriched uranium and sells it to more than 40 countries.



## Russian uranium production, tonnes U

**Table №6**

| Production centre | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|
| Priargunsky | 2011 | 2133 | 1970 | 1977 | | | |
| Dalur | 529 | 562 | 578 | 590 | plan 600 | | |
| Khiagda | 332 | 440 | 442 | 488 | plan 540 | | plan 1000 |
| Gornoye | - | - | 0 | | | | |
| Olovskaya | - | - | 0 | | | | |
| Elkon | - | - | 0 | | | | |
| Lunnoye | - | - | 0 | | | | |

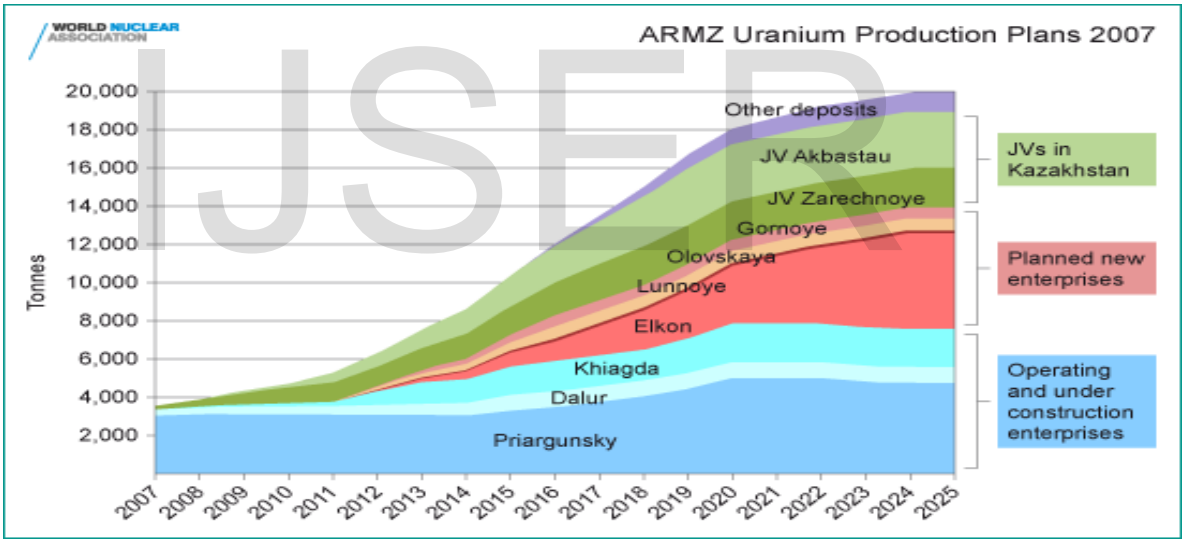
| | | | | |
|---|---|---|---|---|
| **Total** | **2872** | **3135** | **2990** | **3055** |

***Source: 2014 'Red Book' except Olovskaya and Lunnoye***

Russia is giving special importance to increasing its uranium reserve. During federal council meeting of April 2015, Russia made decisions to lift mining taxes, fund measurements in surveying activities, simplify natural resource extraction system in areas of Vitimsky deposit of Buriad Federal Republic, and improve infrastructure in the Far East and Krasnokamensk by 2018. Also more uranium reserves were detected in the Urals, Khalimag and Northern areas of Caspian Sea during recent surveys.

The country has large Uranium reserve and its reserve amounts nine percent of total reserve with unexplored reserve is 505,900 tons. As of September 2015, Russian total uranium reserve is estimated at 517,000 tones[8].

Figure №5




As of 2013, Uranium exploration cost increased two times, reaching 52 million dollars. In addition, a total of 14 billion rubles of investment are planned for uranium mining in North Siberia and Middle East. Uranium mining actives are in the Urals, Baikal lake and Khalimag areas. Other areas of exploration include Zauralsky, Streltsovsky, Vitimsky and Vostochno-Zabaikalsky, and Elkonsky ore regions.

***Main regions of uranium reserve in Russian Federation:***

- Trans-Urals, Chelyabinsk and Omsk

[8] Red Books 2014

- Streltsovsky area near the border area, Trans-Baikal and Chita.
- Vitimsky area, Buriad region 570 km from Krasnokamensk, Khiagda.
- More recent reserves are discovered in Sakha Republic (Yakuta) which is around 1200 km away from the border with China.

## Russian uranium mining

**Table №7**

| Production centre | Region | First production | Orebody | Known resources: tU | Capacity: tU/yr |
|---|---|---|---|---|---|
| Priargunsky | Transbaikal/ Chita | 1968 | volcanic | 98,000 | 3000 |
| Dalur | Trans-ural/ Zauralsk | 2004 | sandstone | 11,000 | 800 |
| Khiagda | Vitimsky, Buryatia | 2010 | sandstone | 32,000 | 1000 |
| Gornoye | Transbaikal/ Chita | deferred | granite | 3200 | 300 |
| Olovskaya | Transbaikal/ Chita | deferred | volcanic | 8210 | 600 |
| Elkon | Yakutia/ Sakha | (2020) | metasomatite | 303,600 | 5000 |
| Lunnoye | Yakutia/ Sakha | (2016?) | polymetallic | 800 | 100 with gold |

***Source: 2014 'Red Book' except Olovskaya and Lunnoye.***

A survey was conducted in Trans-Ural in 2014 and the detected reserves increased from 4700 to 5500 tons. Extracted uranium level of 50 tons is set to increase to 200 tons in 2019.

The Russian nuclear energy production, with 25.264 MW capacity reactors, consists of:

- Introduction of WER-440/230 type pressured water reactors by 2020.
- WER-440/213 pressured water reactor
- WER-1000 pressured water reactor, mainly V-320 type
- 1 unit of BN-600 fast fusion reactor

## Power reactors in operation

**Table №8**

| Reactor | Type V=PWR | MWe net, each | Commercial operation | Scheduled close |
|---|---|---|---|---|
| Balakovo 1 | V-320 | 988 | 5/86 | 2045 |
| Balakovo 2 | V-320 | 1028 | 1/88 | 2033 |
| Balakovo 3 | V-320 | 988 | 4/89 | 2034 |
| Balakovo 4 | V-320 | 988 | 12/93 | 2023? |
| Beloyarsk 3 | BN-600 FBR | 560 | 11/81 | 2025 |
| Beloyarsk 4 | BN-800 FBR | 789 | (2016) | |
| Bilibino 1-4 | LWGR EGP-6 | 11 | 4/74-1/77 | 2019-22 |
| Kalinin 1 | V-338 | 950 | 6/85 | 2025? |

| Reactor | Type V=PWR | MWe net, each | Commercial operation | Scheduled close |
|---|---|---|---|---|
| Kalinin 2 | V-338 | 950 | 3/87 | 2032 |
| Kalinin 3 | V-320 | 988 | 11/2005 | 2034 |
| Kalinin 4 | V-320 | 950 | 9/2012 | 2042 |
| Kola 1 | V-230 | 432 | 12/73 | 2018 or 2033 |
| Kola 2 | V-320 | 411 | 2/75 | 2020 |
| Kola 3 | V-213 | 411 | 12/82 | 2026 |
| Kola 4 | V-213 | 411 | 12/84 | 2039 |
| Kursk 1 | RBMK | 1020 | 10/77 | 2022 |
| Kursk 2 | RBMK | 971 | 8/79 | 2024 |
| Kursk 3 | RBMK | 971 | 3/84 | 2029 |
| Kursk 4 | RBMK | 925 | 2/86 | 2030 |
| Leningrad 1 | RBMK | 925 | 11/74 | 2019 |
| Leningrad 2 | RBMK | 971 | 2/76 | 2021 |
| Leningrad 3 | RBMK | 971 | 6/80 | 2025 |
| Leningrad 4 | RBMK | 925 | 8/81 | 2026 |
| Novovoronezh 3 | V-179 | 385 | 6/72 | 2016? |
| **Novovoronezh 4** | V-179 | 385 | 3/73 | 2032 |
| Novovoronezh 5 | V-187 | 950 | 2/81 | 2035 potential |
| Smolensk 1 | RBMK | 925 | 9/83 | 2028 |
| Smolensk 2 | RBMK | 925 | 7/85 | 2030 |
| Smolensk 3 | RBMK | 925 | 1/90 | 2034 |
| Rostov 1 | V-320 | 990 | 3/2001 | 2030? |
| Rostov 2 | V-320 | 990 | 10/2010 | 2040 |
| Rostov 3 | V-320 | 1011 | 9/2015 | 2045 |
| **Total: 35** | | **26,053 MWe** | | |

***Source: 2014 'Red Book' except Olovskaya and Lunnoye***



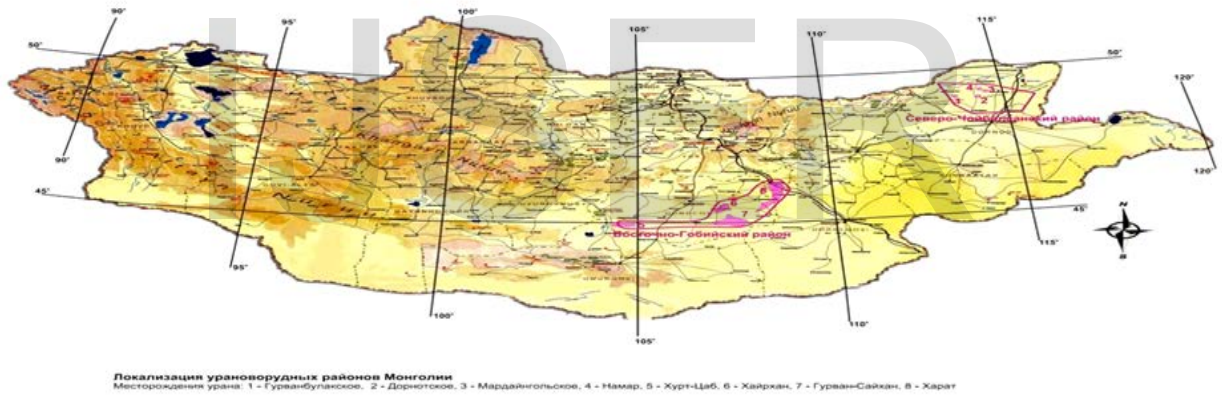
ARMZ reported that in 2008, its production increased as a result of investments from Kameko, Mitsiu and domestic investors. In 2015, its production increased three times reaching 10,300 tons of Uranium. ARMZ planned to make 203 billion rubles of investment in Russian uranium mining development and this investment is aimed to increase production of Uranium to 20000 tons by 2014.

Priargunsky company planned 67 billion rubles of cost for 20000 tons of Uranium by 2024. The company has profited of 30 million dollars from it in 2009.

***Three. Mongolia's cooperation in the uranium field:*** Survey of Mongolian uranium reserve is divided into several stages, based on conducted date, type of surveillance and scope. During 1940s, geological expeditions for uranium survey has been conducted in the East and South East part of Mongolia and several reserves of uranium have been detected along with brown coal

deposits. Surveys for uranium continued during 1970s, based on the cooperation agreement between People's Republic of Mongolia and Soviet Union with planned surveys conducted in the Eastern part of Mongolia financed directly by Soviet Union. Since the end of Cold war in 1990s, domestic social and economic situations prevented Mongolia to make any investment in the geological survey of uranium for over a decade. This situation changed after 2000s, when private companies started to enter the field with discovery of deposits in Kharaat, Khairkhan, Dulaan Uul, Zuuvs Ovoo and others, including 9 deposits, 100 findings, and more than 1000 mineral spots. Estimated 130 thousand tons of uranium reserves are in Mongolia. International Atomic Energy Agency's Red Book lists Mongolia as 16$^{th}$ in the world for most discovered uranium reserve and 6$^{th}$ in Asia after Kazakhstan, Uzbekistan, China, India and Russia.

Figure №6




Локализация урановорудных районов Монголии
Месторождения урана: 1 - Гурванбулакское, 2 - Дорнотское, 3 - Мардайнгольское, 4 - Намар, 5 - Хурт-Цаб, 6 - Хайрхан, 7 - Гурван-Сайхан, 8 - Харат

***Uranium mining in Mongolia*:** Construction of "Erdes" factory with capacity of two million tons of ore started in 1982 and finished in 1988 basing on uranium reserves in Dornod Aimag. Ores mined at this factory were delivered to Krasnokamensk city's mineral and chemical factory in Chita region of Russia without any enrichment process. Currently established uranium deposits are Khairkhan Uul, Kharaat, Gurvanbulag, Dulaan Ovoo, Gurvansaikhan, Ulziit and Zuuvch Ovoo. Chinese company Sinouranium is conducting uranium exploration around Gurvanbulag deposit in Dornod Aimag and holds the license to it. This deposit is located 111 km from North of Choibalsan city and 15 km South East from Bayandun soum center in Dornod Aimag.

During 1977-1981, a provision survey was conducted and registered the deposit site as C2 level with detailed exploration coming in 1979. Total cost of Soviet explorations in this site

amounted 56.88 million rubles. The site is comparatively large in size; its reserve may increase with further explorations, and the initial feasibility study was based on an estimate that the site would be mined for 22 years. Detailed exploration of the site was conducted in 1982-1987 and increased the previous estimate to 10560.0 thousand tons and 16073 tons of uranium with C1+C2 level[9].

Mongolia has signed 16 treaties and memorandums with 8 countries on issues concerning radioactive minerals and nuclear energy.

**Agreements and Memorandum of Understanding**

**Table №9**

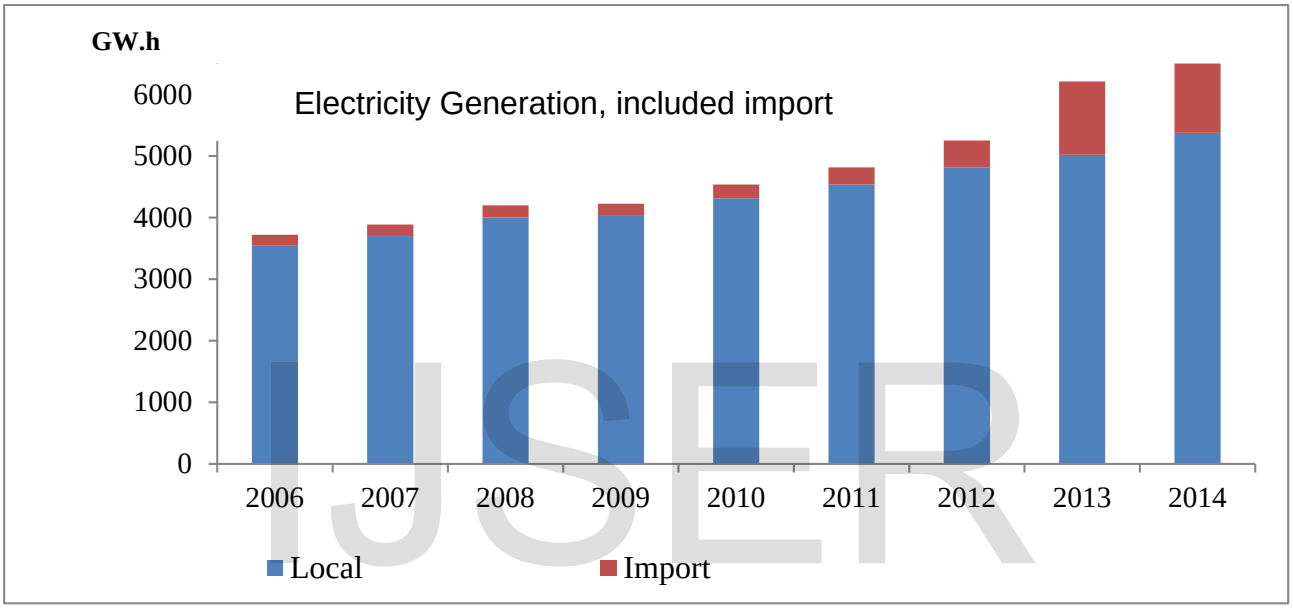
| № | Country | Agreement | | | Memorandum | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 2000 | 2009 | 2010 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
| 1 | Russia | 1 | 2 | 1 | 1 | | | 1 | | |
| 2 | Japan | | | | 1 | | | | | |
| 3 | India | | | | 1 | | | | | |
| 4 | China | | | | | 1 | | | | |
| 5 | France | | | 1 | | 1 | | | 1 | |
| 6 | USA | | | | | 1 | | | | |
| 7 | Korea South | | | | | 1 | 3 | | | |
| 8 | Czech Republic | | | | | | | 1 | | |
| 9 | Canada | | | | | | | | | 1 |
| Total (19) | | 1 | 2 | 2 | 3 | 4 | 3 | 2 | 1 | 1 |

The main energy demand is predicted to grow from 2480.31MW to 8526.86MW in 2035. Currently, Mongolian combined capacity of power plants is 891MW, which is an inadequate capacity to supply energy needs in far future. Rightfully this issue leads to establishment of new power plants, but also

[9] Using nuclear energy in Mongolia, Academic Conference. Ulaanbaatar. 2010

brings the choice of whether the new power plants would be nuclear or thermal. Nuclear energy cost is usually around 1.76 cent KW per hour, while coal based thermal energy costs 2.47 cent KW per hour, and natural gas costs 6.28 cent KW per hour[10]. This shows that we have the possibility to establish nuclear power plant basing on domestic uranium reserves and become a uranium exporter country.

Figure №7



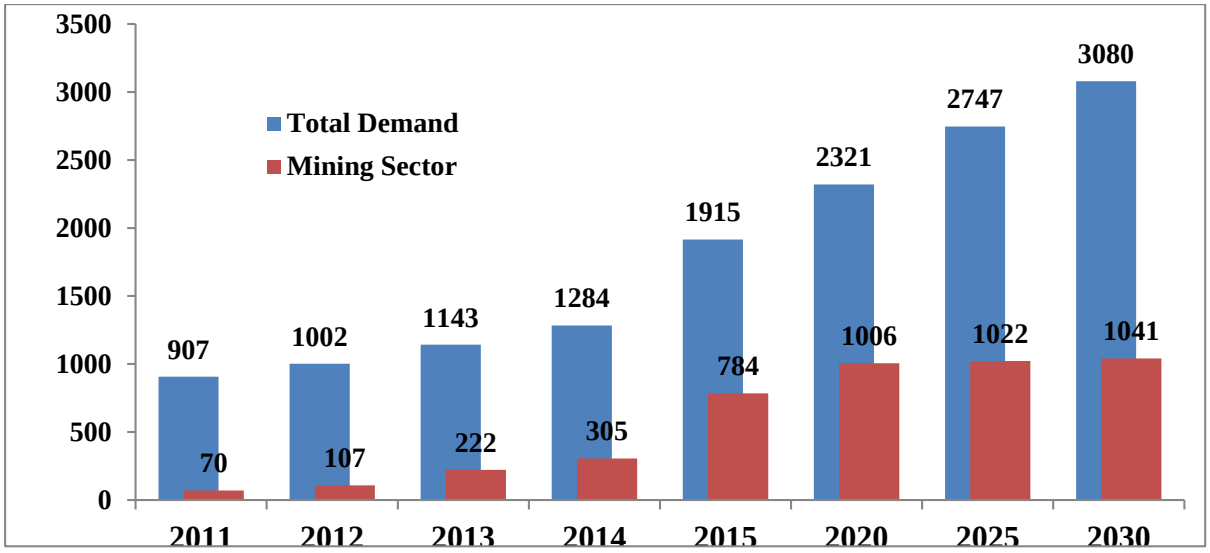

Source: National Statistical Committee

In 2014, a total of 6.7 TW.h of electricity was produced, in which 80% was generated locally, 20% imported from Russia and China. Average annual electricity consumption growth was 9% and heat consumption growth in urban areas was 3.6%. The total electricity production loss is 13.7%;

**DEMAND FORECAST, 2011-2030**

Figure №8

[10] Uranium Letter International Presentation. March 2011




Source: Energy Authority of Mongolia, 2012

***Possibility of Uranium export for Mongolia*:** All types of exports from Mongolia, including uranium, should be viewed in conjunction with its two neighbors who take 80 percent of total foreign trade of the country. Thus, I have analyzed uranium consumption, nuclear and uranium sector, and uranium export possibility in the two neighbor countries. Our two neighbors are placed second in the world for most planned nuclear reactors. World's biggest economy, China, declared its readiness for importing electricity energy from Mongolia. Also, researchers note that Russia is ready to export energy to East Siberia and North Korea.



The figure shows that uranium need of nuclear reactors in Mongolia's two neighboring countries is increasing and will continue to. This given situation is opening a possibility to export uranium.

| COUNTRY | 2008 | 2009 | 2010 | | 2015 | | 2020 | |
|---|---|---|---|---|---|---|---|---|
| | | | Low | High | Low | High | Low | High |
| China | 1 800 | 3 300 | 2 340 | 4 600 | 4 600 | 6 450 | 6 450 | 8 200 |
| Russia | 4 100 | 4 500 | 5 400 | 5 400 | 7 200 | 7 700 | 8 200 | 9 700 |

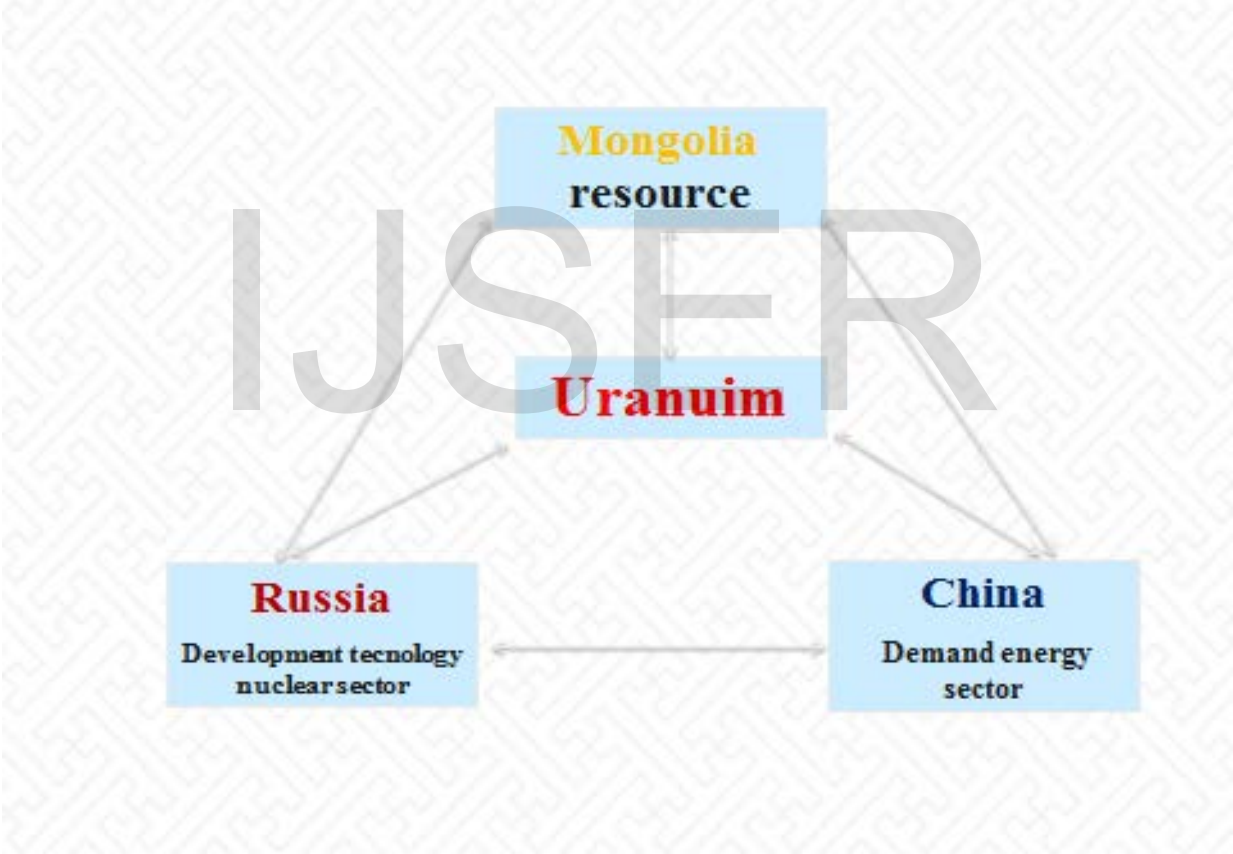
**Profits of uranium export**: Currently Mongolia has 15694.5 tons of uranium ready for mining and "Gurvan Saikhan LLC" operates the reserve deposit. Researcher calculated that if these deposits are mined during 2010 to 2017, profit required for further stages could be acquired[11]. I believe the development of regional trilateral cooperation between Mongolia, Russia and China is

[11] Nuclear energy commission

necessary. The second joint meeting of the three countries held on July 9th 2015 proves necessity of such cooperation, and creates a favorable condition for Mongolia to develop beneficial cooperation in the field with Russian nuclear technology and China's growing energy demand.

**Table №10**

| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|
| **Total uranium reserve, in thousand kg** | 2242.1 | 2242.1 | 2242.1 | 2242.1 | 2242.1 | 2242.1 | 2242.1 |
| **Cost of uranium, USD/kg** | 111.1 | 133.3 | 155.5 | 166.6 | 177.7 | 188.8 | 200 |
| **Total profit of export, in million USD** | 249 | 299 | 349 | 373 | 398 | 423 | 448 |



## Conclusion

1. Mongolia faces issues with its cooperating countries with advanced nuclear energy technology concerning nuclear energy production, in order to raise more forward-looking initiatives. It is important to utilize international cooperation in energy supply and nonproliferation of nuclear weapons.
2. Mongolia or any other countries which have minimal experience in nuclear energy should spend lots of effort in researching and learning from countries with more experience in the field in order to increase awareness and technology on the issue.
3. Energy consumption of Russian and China is expected to grow and its domestic reserve is becoming stretched and may not be able to supply the needs in the future. In this respect, it is becoming important to consider the fact that the two countries are prioritizing stable supply of energy from the surrounding countries and their energy policy is overlapping over Mongolia.
4. Mongolia is one of the few countries with abundant uranium resource and this resource creates us an option to develop the economy. In this respect, production and export of enrichment, construction and operation of high tech nuclear power plants, and treatment of uranium and implementation of other peaceful usages, cooperation in this field, and creation of legal environment are needed as initial steps.
5. The price, demand and supply of uranium are constantly increasing, while uranium deposits are decreasing. Thus, this issue is catching worldwide attention than ever before.

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