Fueling the Future:
Mongolian Uranium and Nuclear Power Plant Growth in China and India

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Abstract
Increased nuclear electricity generation in China and India presents uranium suppliers such as Mongolia with an opportunity to develop its uranium and nuclear industry. This paper discusses the Mongolian potential for interaction with the two larger nations, given the strategy, organization, and future developments in each respective nuclear sector. The paper will focus on front-end developments, where government-level agreements will likely dominate the uranium mining and supply negotiations. Established players such as France and Russia are poised to secure fuel resources from around the world, but the most of demand will be China and India. Therefore, this paper focuses on China and India as primary objects of study and link Mongolia's growth with these markets.

Introduction
Mongolia's contribution in the nuclear arena has thus far been limited to providing uranium for military and civilian purposes. Conventional estimates place Mongolia's uranium reserves at 62,000 tons[1], but untested reserves may raise the estimate to 1.39 million tons, constituting the largest reserves in the world.[2]

During the communist era, strong ties with the Soviet Union led to extensive joint explorations. Beginning in the 1970's, successful geological studies resulted in exclusive concessions to Soviet mining interests.[3] Russian uranium mining companies have continued to operate in Mongolia given their existing technical expertise in the uranium reserves areas. Recent dialogues with Russian dignitaries, such as Prime Minister Putin's May 2009 official visit, have resulted in agreements to jointly develop the uranium deposits and fuel cycle facilities.[4]

While Mongolian-Russian joint ventures are currently gaining much attention, Mongolia is rightfully diversifying investments partners in its nuclear industry sector to avoid over reliance on any single party. Such diversification can take place through direct investment from foreign corporations, the development of local mining groups, and

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[1] *Uranium 2007: Resources, Production and Demand*, at $130/ kg U.
[2] "Japan, Mongolia meet on uranium." UPI, 14 Oct. 2008. Web. 25 Aug. 2009. <http://www.upi.com/Energy_Resources/2008/10/14/Japan-Mongolia-meet-on-uranium/UPI-37711224009074/>.
[3] Mays, William M. *The Dornod Uranium Project in Mongolia*. Rep. The Uranium Institute, 1998. Web. 25 Aug. 2009. <http://www.world-nuclear.org/sym/1998/mays.htm>.
[4] Daly, John C.K. "Analysis: Russia wins Mongolian uranium mining concessions." UPI, 18 May 2009. Web. 26 Aug. 2009. <http://www.upi.com/Energy_Resources/2009/05/18/Analysis-Russia-wins-Mongolian-uranium-mining-concessions/UPI-84271242688804/>.

government-to-government agreements.

This report highlights the government-level interactions of Mongolia with China and India in the nuclear arena. Currently, agreements between state-run actors appear to be gaining ground over investment agreements from private foreign companies. The choice of countries and types of agreement, discussed in this report, emerge for four principal reasons:

1) The current investment environment favors state actors, who wish to guarantee national access to uranium as a strategic resource.

Currently, state-owned corporations from abroad are expressing the greatest interest in developing Mongolia's uranium resources. These groups consider uranium as a strategic resource, and are thus willing to make investments even at a loss. The lack of profitability potential in the uranium investments may be explained by the extreme deficiency of appropriate infrastructure and the domestic political desire to maintain a government equity share in the resource extraction process. The Nuclear Energy Law of 2009 has codified this situation by expropriating to MonAtom, without compensation, at least a 51% stake in licenses developed with state exploration funds, and 34% in those explored independently. This recent policy change presents an unfavorable climate to foreign investors, who are both wary of forced government participation and legislation which dramatically changes the legal structure of investment even after significant funds have been spent. The requirement for state equity participation and the need for intensive infrastructure investment are more palatable to foreign state-owned investors seeking to secure access to uranium supplies.

2) Mongolian policymakers have a history of partnerships with foreign governments, and appear to be content in extending such precedent.

Beyond the aforementioned agreements with the Russian government, Mongolian policymakers have viewed government-to-government interactions as essential for broadening the country's diplomatic relationships. The Nuclear Energy Law of 2009 explicitly prefers investors to be "strategic partners," defined as state-backed enterprises or private companies with a proven track record. Given the unfavorable investment proposals integrated into the legislation, the government has clearly created conditions where the only remaining "strategic partners" would be state-backed actors.

3) **China and India present the greatest area of growth in the Asia-Pacific region**

Massive amounts of investment in electricity production through nuclear power plants (NPPs) are currently being undertaken in both India and China due to human health, climate change, and energy security concerns. India plans to increase its nuclear energy production from 3667 Mwe to 20,000 Mwe by 2020 and 63,000 Mwe by 2032, which will comprise 25% of total electricity production[5]. Meanwhile, China is building advanced reactors that will increase its capacity from the current 8587 Mwe to at least 60 Gwe by 2020 and 120 - 160 Mwe by 2030, aiming to produce 4% of its total electricity production from nuclear sources[6]. In terms of the international legal environment, India

[5] "Nuclear Power in India." World Nuclear Association. July 2009. Web. 26 Aug. 2009. <http://www.world-nuclear.org/info/inf53.html>.

[6] "Nuclear Power in China." World Nuclear Association. 19 Aug 2009. Web. 26 Aug. 2009.

has recently acceded to the Nuclear Suppliers Group, enhancing opportunities for growth and international connections to construct additions NPPs. China, meanwhile, has embraced foreign technology, leading even the highly protective U.S. congress to approve nuclear trade with the mainland through the US - China Nuclear Cooperation Agreement. As a result, China and India are becoming the fastest growing players in the world nuclear power market.

4) The dominant actors in the Chinese and Indian nuclear market are state-owned corporations. Both nations have liberalized and embraced globalization throughout their economies, but the nuclear sector retains heavy state involvement. These state corporations are interested in guaranteeing supplies for domestic NPPs through direct investment in Mongolian mines. In addition, these state enterprises have partnered in joint ventures with other multinational nuclear supply corporations, such as Areva, Rosatom, GE, and Westinghouse to construct new NPPs. Such companies have also expressed interest in Mongolian uranium deposits as a means to develop a complete front-end supply network in the region. However, national policymakers in both Indian and China are looking to develop indigenous capabilities over the entire fuel cycle, and thus would prefer to invest directly in Mongolian uranium reserves through state-backed companies. Both nations hope to create "national champions", similar to Areva, that would stimulate an extensive nuclear industry base at home and abroad.

The Chinese Nuclear Industry

Overview

As the leading economy in Asia, China is eagerly pursuing NPPs in order to power the next stage of economic development. After its previous reliance on coal, which has extensive human health and climate change impacts, China is looking to diversify its energy sources. Chinese electricity demand is expected to grow 110-190% by 2020[7]. Much of this growth will occur in the southeast coastal regions of China, where there is a paucity of coal reserves.

Current government growth plans are for 4% of China's electricity to come from nuclear sources by 2020, which requires two NPPs per year to be built. According to China National Nuclear Corporation, the following decades will have three distinct phases for NPP development. Until 2020, the focus will be on Pressurized Water Reactor thermal neutron reactors, after which China will shift to fast breeder thermal neutron reactor until 2050. Beyond that stage, current plans call for a continuation of the fast breeder thermal neutron reactor program as well as controlled nuclear fission reactors.[8]

China has several uranium mine sites coupled with nearby processing infrastructure Current mine sites have around 64,000 tons in reserves.[9] This figure is roughly equal to the current estimate of Mongolian reserves, barring any further exploration. Current production stands at 730 tons of uranium per year. China has recently embarked on projects to increase efficiency at uranium mine sites, and recently

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<http://www.world-nuclear.org/info/inf63.html>.

[7] Shealy, Malcolm, and James P. Dorian. *Growing Chinese Energy Demand*. Rep. CSIS, Oct. 2007. Web. 26 Aug. 2009. <http://csis.org/files/media/csis/pubs/071019-growingchineseenergy-a.pdf>.

[8] CNNC. Weike Cong. *Nuclear Industry in China*. Web. 26 Aug. 2009. <http://www-pub.iaea.org/MTCD/Meetings/PDFplus/2009/cn175/URAM2009/Session%201/8_33_Cong_China.pdf>.

[9] OECD and IAEA, *Uranium 1995: Resources, Production, and Demand*, p. 136

discovered sites in Inner Mongolia and Xinjiang.

One large impeding concern for NPP development is the desire to maintain energy production from domestic resources. While China has some uranium deposits, it seems like the national security frame is less influential in the nuclear debate as China has aggressively pursued uranium in Africa. The addition of Mongolian uranium to the energy mix may complicate China's energy sources, but over reliance does not appear to be an issue. China has developed a closed nuclear cycle, providing an opportunity to build national energy independence and reduce the need for foreign uranium imports.

China has also been developing uranium contacts in Australia, the largest uranium producer. However, Australian regulators have recently rebuffed attempts by Chinese companies to acquire stakes in uranium mines. As a result, Chinese nuclear officials are studying less developed suppliers as possible partners. Suppliers currently gaining market share include Kazakhstan, Jordan, and several African nations.

Organization

Leadership in the Chinese nuclear sector is split between three main parties. The State-Owned Assets Supervision & Administration controls the state-owned economy, under which much of the nuclear industry falls. The National Energy Commission serves as a policy organization to develop strategies for fulfilling China's energy needs. Finally, the National Energy Administration serves as the implementing body.

There are multiple local corporations running NPPs throughout the country. The major shareholder in projects in the China National Nuclear Corporation, which has subsidiaries and departments extending to every aspects of the nuclear running cycle, from research and development, uranium mining, and all aspects of the fuel cycle.

The major exploration group relevant to bilateral deals with Mongolia will be SinoU. A fully-owned subsidiary of CNNC, the organization targets overseas mining projects. SinoU has partnered with the government of Niger with a minority stake in a uranium development. This project, taking place with the help of private Chinese firms, would serve as a template for future developments in Mongolia. However, the possibility for direct Chinese involvement is slim as the Mongolian government maintains a historical bias against Chinese investments and any appearance of an imposition on its sovereignty.

Processing and enrichment of uranium takes place in four facilities, which serve dual purposes in providing for both civilian and military uranium needs. Domestic pressure for full fuel cycle capabilities will push China to further develop its enrichment capabilities to serve growing NPP demand. These facilities are now being developed in the southern areas of China, near the fast-growing coastal regions, where most of the NPPs are planned.

The Indian Nuclear Industry

Overview

The Indian nuclear industry is currently expanding rapidly in order to ameliorate energy security and environmental concerns. Indian electricity demand is projected to almost double by 2020[10], and nuclear power is emerging as a key means of providing for

[10] http://www.companiesandmarkets.com/Summary-Market-Report/india-power-report-q3-2009-154345.asp

India's rapid economic development.

India's planned nuclear power plants will require an increase in nuclear supplies, primarily uranium. Current mines produce only 271 tons per year.[11] Mining plans are projected to increase this figure, with at least three large mines and additional mill facilities within the next five years to achieve greater self-sufficiency. The current capacity for uranium production in India is extremely low, and the available resource is of low quality. Most mines vary between 0.03–0.06% U_3O_8, while most international uranium mines are only developed at the 2% or more thresholds.[12] U_3O_8 output from current mills is projected at 420 tons/year U, which includes both mined and by-product inputs.[13] The civilian and military nuclear programs burden these minimal supplies, with priority going to weaponry uses. As a result, current NPPs usually run below capacity as they lack sufficient fuel.

The choice to develop current mines was highly influenced by the scarcity of domestic uranium supplies. To counteract the low quality and quantity of uranium, India is also planning to exploit its more extensive thorium reserves to power future NPPs. In addition, India has recently been embraced by the US as a potential location for reprocessing spent nuclear fuel of American origin.[14] The development of NPPs based on thorium and plutonium supplies are an attempt to lessen the need for raw uranium.

The historic US-India Civilian Nuclear Agreement, which granted India an exemption from restrictions on nuclear trade between Nuclear Supplier Group (NSG) nations and non-signatories to the Non-Proliferation Treaty, will serve as a building block for nuclear agreements between India and the world. The agreement required India to separate its civilian facilities from its military program and place them under International Atomic Energy Agency supervision. In return, the United States, in particular, would agree to full nuclear cooperation. The NSG, which had originally formed in the wake of India's nuclear test in 1974 to regulate the trade in nuclear materials, effectively allowed India full access to worldwide nuclear supplies. NSG nations and the US granted this exemption for strategic and commercial reasons. India proudly holds the title of the most populous democracy in the world, and unlike Pakistan, has not engaged in proliferation activities. Western companies have wanted access to the fast growing energy market, in order to take part in the rapid increase in the number of NPPs.

This agreement strengthens the opportunity for Mongolia to engage in nuclear exchanges and agreements with India, as these discussions now have the cover of legitimacy from the NSG.

Nuclear Power Program Strategy

Current plans call for India to generate 25% of its electricity from nuclear sources by 2050. To achieve this goal, India has planned its civilian nuclear development in three stages. Stage I, largely defined until 2020, is comprised of Pressurized Hot Water

[11] http://www.world-nuclear.org/info/inf23.html

[12] Curtis, M. M. India's Worsening Uranium Shortage. Rep. Pacific Northwest National Laboratory, Jan. 2007. Web. 26 Aug. 2009. <http://www.pnl.gov/main/publications/external/technical_reports/PNNL-16348.pdf>.

[13] Ibid.

[14] "India, US meet on reprocessing fuel ends." Live Mint. Wall Street Journal, 25 June 2009. Web. 26 Aug. 2009. <http://www.livemint.com/2009/07/25144815/India-US-meet-on-reprocessing.html>.

Reactors and Light Water Reactors. Stage II is planed to begin construction of Fast Breeder Reactors, and in Stage III, India plans to diversify away from uranium by building Thorium-Based Reactors.

Given the low quality of domestic uranium reserves, India has looked abroad to secure supplies. India's foreign sources of nuclear fuel include arrangements with multinational corporations, such as Areva, which are involved in other aspects of the industry. In addition, the Indian government has embarked on plans to guarantee supplies from Kazakh and Russian sources in agreements sanctioned by the respective governments. However, Australia, a major uranium exporter, has so far refused to allow exports to India due to its status as a NPT non-signatory.[15]

Organization

The nuclear power industry in India is run under the auspices of the Atomic Energy Commission. The commission directs the overall direction of the Indian Nuclear Industry and sets priorities based on national security, economic priorities, and scientific research considerations. The board is composed of members of the scientific and policy community, ranging across various agencies from within the Atomic Energy Commission and in other cabinet and government offices.

The Department of Atomic Energy administers nuclear-related affairs. Its subsidiary organizations include research and development organizations, public sector undertakings, industrial organizations, and service and support organizations. Technical cooperation with the Indian nuclear infrastructure would take place under the auspices of this organization.

In the specific areas of mineral exploration, the Atomic Minerals Directorate for Exploration & Research, located in Hyderabad, presents the greatest opportunity for short-term cooperation. Mongolia's vast unexplored resources, along with a general lack of sufficient technical analysis capacity, presents a great challenge for the development of uranium resources. Increased Indian involvement in the sector could involve training seminars for Mongolian counterparts as part of any bilateral trade deals.

The Uranium Corporation of India, Ltd. (UCIL) operates uranium mines in India. Unlike its Chinese counterpart, UCIL has yet to embark on large-scale projects abroad. The group's relative lack of international experience, and lessened worries of Chinese encroachment on Mongolian sovereignty, may provide a greater potential for an agreement with UCIL. The Mongolian government will be able to negotiate for better conditions, and the Indians may be much more willing to invest directly and guarantee their stake in new mineral developments. Trade relations with India also serve Mongolia's goal of forming ties along its "Third Neighbor" strategy.[16]

The Indian Nuclear Industry has multiple research arms and several organizations focused on various stages of development and process. By beginning cooperation on the uranium front, Mongolia could develop future relations with research institutions, and train Mongolian researchers and academics in India.

Processing and enrichment will continue to largely take place domestically, at the

[15] "Australia bans India uranium sale." BBC News, 15 Jan. 2008. Web. 26 Aug. 2009. <http://news.bbc.co.uk/2/hi/asia-pacific/7188835.stm>.

[16] The "Third Neighbor" strategy refers to the Mongolian post-communist foreign policy doctrine advocating for expanded relations with nations other than China and Russia.

Nuclear Fuel Complex in Hyderabad. It is reasonable to assume that India would prefer to develop beyond its current capacity with Mongolian uranium as a source material. By maintaining domestic enrichment, India will fortify its energy security. Currently, some of India's supply needs are met through foreign fuel deals, particularly for NPP models based on foreign designs.

Mongolian Nuclear Industry

Mongolia is currently looking to strengthen the domestic framework for the nuclear sector. The government has played a leading role in all nuclear-related efforts, and this trend will continue in the near future. Even more so than its other minerals, Mongolia clearly views uranium as a strategic resource that must remain under the purview of central authorities.

Background

The Mongolian nuclear effort began in 1962 as the Nuclear Energy Commission under the Ministry of Education and Culture, which later developed into the Nuclear Energy Agency (NEA). During the transition to a democratic society, Mongolia declared its status as a Nuclear Weapons Free State, and in 2003, the parliament ratified the NPT. In 2008, legislation elevated the NEA to the ministerial level and appointed the Prime Minister as the agency chair. Today, the MonAtom Corporation has been charged with leading the uranium extraction process and developing the domestic nuclear process.

Recent Developments: The Nuclear Energy of 2009 and Its Impacts

The Nuclear Energy Law (NEL) of 2009 emerged as another effort by the government to exploit the country's natural resources. Private companies had previously maintained that the current minerals law, with a few additional corollaries regarding radioactivity, the environment, and human health, could competently apply to uranium mining as well. However, the parliament has decided to delegate large-scale involvement and control to the NEA and its related organizations.

The legislation's most game-changing provision is the designation of all uranium reserves, regardless of size, as "strategic" reserves, which leads to specific government controls (Sect. 6). In the NEL, the free state equity participation emerges a key means for state involvement in the sector. The state must acquire at least a 51% stake in developments explored with state monies, and a 34% stake in independently explored sites (Sect. 5.1.2, 5.1.3). Other regulations expanding state involvement include requirements for approval for governing board structure and any transfer of shares above 5%, and a separate approval structure for uranium exploration separate from other minerals.

These provisions, on the whole, present quandaries to private investors. Unlike state entities, which take into account strategic and political considerations, private investors make decisions based on the profit-making capacity of projects. Even though the overall investment climate for mining is improving, for uranium sector, Mongolia's unfavorable investment environment for independent operators has become worse as the government has stepped forward to demand an uncompensated stake in each venture. From the nationalist-minded Mongolian perspective for uranium, the law ensures that regulators will be able to directly influence company actions and that only approved

parties, particularly excluding Chinese investors, will take part in uranium projects.

Private mining corporations are currently working to create arrangements that will result in benefits for all stakeholders in uranium projects. In order to remain profitable in the face of government revenues, corporations have designed schemes in which the main mine developer would contribute the government's stake in the initial mine investment. Once the mine becomes profitable, the developer would recoup the government's share of the investment funds by using the dividends scheme as compensation.

Outlook

The Mongolian government will likely formalize its rules and parameters for investments in the coming years as planned projects move through the regulatory system. The government will continue to exert heavy influence over projects, which may result in exacerbating current corruption issues.

Private operators, particularly large multinational corporations, still have an advantage in the marketing and sale of mined uranium. Particularly in the case of the Chinese market, from which direct investment is unlikely, these corporations can play a vital link between Mongolian supplies and large demand markets.

The Nuclear Energy Agency and the MonAtom Corporation have important mandate for their country to develop the uranium sector responsibly. The rapid growth in nuclear energy markets in India and China presents an opportunity for growth for nuclear suppliers such as Mongolia. Mongolian policymakers have the opportunity to take advantage of the rising price of uranium and nearby demand centers to further develop the nation.