



## DECISION TIME: US-SOUTH KOREA PEACEFUL NUCLEAR COOPERATION

By Fred McGoldrick and Duyeon Kim

### Abstract

Washington and Seoul are negotiating the replacement of their 1974 civil nuclear cooperation agreement that expires in March 2014. Section 123 of the U.S. Atomic Energy Act (AEA) requires exports of US nuclear material and equipment be made pursuant to a peaceful nuclear cooperation agreement, and that cooperating partners agree to stringent nonproliferation conditions as a condition of US supply. The AEA also requires a proposed agreement lie before Congress for ninety days of continuous session before it may enter into effect. Given the Congressional calendar, an agreement realistically should be submitted to Congress by spring or early summer of this year. The clock is ticking, and the negotiators are stuck on two contentious issues: South Korean demands for US approval to 1) enrich any natural uranium supplied by the US, and 2) reprocess (or in the case of South Korea, pyroprocess) used fuel produced from nuclear material covered by the agreement and reuse the recovered nuclear material in its peaceful nuclear power reactors. Since enrichment and reprocessing (or pyroprocessing) can yield both fuel for peaceful nuclear energy and material for nuclear weapons, the US strongly opposes the spread of these technologies, particularly in areas of proliferation concern and instability such as the Korean Peninsula. Concerns are mounting that the allies may not be able to resolve their differences before the present agreement expires. How the two sides deal with these issues could have important implications not only for their nuclear trade but also for the US-ROK-alliance, future US peaceful nuclear cooperation agreements, the global nonproliferation regime, and the North Korean nuclear threat.

**Key words:** *US-South Korea civil nuclear cooperation agreement replacement, Korea, enrichment, pyroprocessing, nonproliferation, nuclear energy*

### Introduction and Background

The US and ROK nuclear industries have been interdependent since Westinghouse constructed South Korea's first nuclear power plant that began operations in 1978. Since then, US firms continued to remain closely involved in Korea's nuclear industry. At the same time, Korean companies like Doosan supply a variety of goods to US nuclear power plants and companies constructing plants overseas. Westinghouse, which is now part of the Japanese firm Toshiba, is involved in the South Korean contract for building four reactors in the United Arab Emirates.

US exports of nuclear material and equipment to South Korea are presently subject to the US-Republic of Korea agreement for peaceful nuclear cooperation. The agreement contains a number of nonproliferation assurances by the ROK. It, however, does not contain reciprocal nonproliferation controls since South Korea was not a nuclear exporter and did not supply nuclear equipment or technology to the United States when the pact was concluded in 1974. The South Korean nonproliferation assurances to the United States include a guarantee that the ROK will not use materials and items subject to the agreement for atomic weapons, for research or development of atomic weapons, or for any military purposes, and International Atomic Energy Agency (IAEA) safeguards will be applied to the materials subject to the agreement. The 1974 agreement also provides that the reprocessing or alteration in form or content of US-supplied materials may be performed only in facilities acceptable to both parties upon their joint determination that IAEA safeguards may effectively be applied to such nuclear operations. This provision constitutes a so-called "prior consent right"<sup>1</sup> to reprocessing. The agreement also contains a US right to approve the retransfer of any items subject to the agreement to a third country. It does not provide the US with the right to

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approve enrichment since the purpose of the agreement was to supply already enriched uranium.

The allies must conclude a new agreement before it expires in March 2014 in order to prevent a halt to US nuclear exports to South Korea. Any new agreement must contain a range of new nonproliferation assurances and guarantees contained in the 1978 Nuclear Non-Proliferation Act (NNPA) that amended the US Atomic Energy Act (AEA).<sup>2</sup> The amendments to the AEA are aimed at significantly expanding the nonproliferation guarantees, assurances, and rights that nuclear trade partners must give to the United States in all future agreements. These include peaceful, non-explosive use assurances, guarantees that IAEA safeguards will apply to all the peaceful nuclear activities of the recipient state (“comprehensive safeguards”), the perpetuity of those safeguards even if the agreement terminates, and assurances of adequate physical protection. Also included is a range of US rights to approve sensitive nuclear activities such as enrichment, the reprocessing or alteration in form or content of used nuclear fuel, and storage of weapon-usable materials—plutonium and highly enriched uranium (HEU).

Unlike the existing agreement, a new US-ROK agreement will contain reciprocal nonproliferation guarantees, thus removing the one-sidedness of the current agreement. On the other hand, the conditions required by the AEA for new agreements go considerably beyond those contained in the current bilateral agreement. For example, the existing pact does not contain a US right of prior approval to enrichment or storage of plutonium or highly-enriched uranium (HEU). In addition, the requirement for prior consent to reprocessing and alteration in form or content is quite far-ranging in scope. The AEA requires that these prior consent rights apply not only to US-supplied nuclear material but also to non-US-supplied material irradiated in a US-origin reactor. Thus the prior US consent rights required by the AEA are much broader and more intrusive than that of the current US-ROK peaceful nuclear cooperation.

### Issues for a New US-ROK Peaceful Nuclear Cooperation Agreement

The two governments agree on most of the nonproliferation conditions required by the AEA. However, they have been unable to resolve their differences over US exercise of two consent rights mandated by the AEA. In particular, the ROK appears to want the US to give it a one-time consent to enrich US-origin uranium and pyroprocess used nuclear fuel subject to the new agreement for the life of the agreement. But the US has been resistant, given its long-standing opposition to the spread of enrichment and

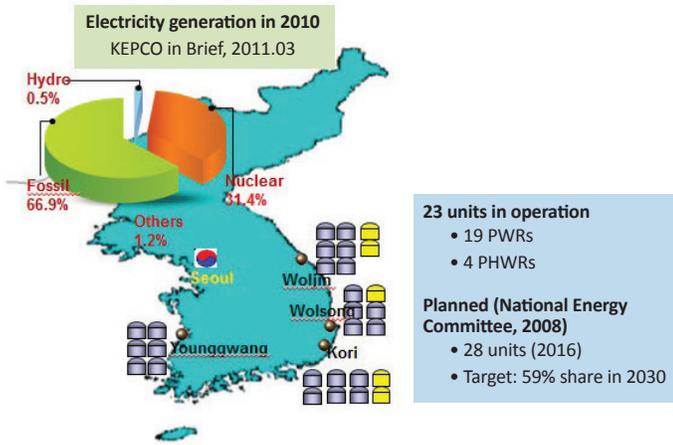
reprocessing technology. US views on these technologies are shaped by concerns that they can be used to produce nuclear weapons as well as to manufacture fuel for peaceful nuclear reactors. In addition, safeguarding reprocessing plants to detect the diversion of plutonium for nuclear weapons is deemed both costly and technically challenging.

As a result the US, as a matter of policy, does not export either technology. It has given consent to only a few of its cooperating partners to enrich US-supplied uranium but only up to 20 percent in the isotope 235. Enrichment beyond that level greatly accelerates the time it would take a country produce weapons-grade uranium (around 90 percent for U-235). The US has peaceful nuclear cooperation agreements with 24 states, Taiwan, and two international organizations, but has limited its approval to the European Atomic Energy Community (EURATOM), Japan, and more recently, India. In each of these three cases the US has given so-called “programmatic consent,” i.e., advance consent to reprocessing and the use of plutonium in the peaceful nuclear programs of these countries under specified nonproliferation conditions for the life of the agreement. The US consent to sensitive nuclear activities in these three cooperating partners is based on the rationale that those states possess major civil nuclear programs, already have a reprocessing capability, are adhering to their nonproliferation obligations, and are important strategic partners of the United States.

Even though the ROK has a large civil nuclear program, adheres to its nonproliferation commitments, and is a close US ally, Washington has been unwilling to grant similar approval to any enrichment or reprocessing of US-supplied material to South Korea. Although the US is not concerned about Seoul using such facilities for nuclear weapons, it is apprehensive about the presence of such capabilities in areas of instability or serious proliferation concern such as the Korean Peninsula where Pyongyang continues to test missiles and nuclear weapons in defiance of UN Security Council resolutions. Washington is concerned that US consent to these sensitive activities in South Korea would make it extremely difficult to persuade Pyongyang to dismantle its enrichment or reprocessing programs and damage its efforts to prevent their spread to other countries. Moreover, some in Congress are seeking to enact new legislation that would pressure all potential nuclear trade partners to forswear enrichment and reprocessing capabilities – the so-called “gold standard,” an obligation that only the United Arab Emirates has accepted in its agreement with the United States.

The view from Seoul is quite different. South Korea sees its civil nuclear power program as comparable to those in EURATOM,

Figure 1: Current Status of ROK Nuclear Power Plants

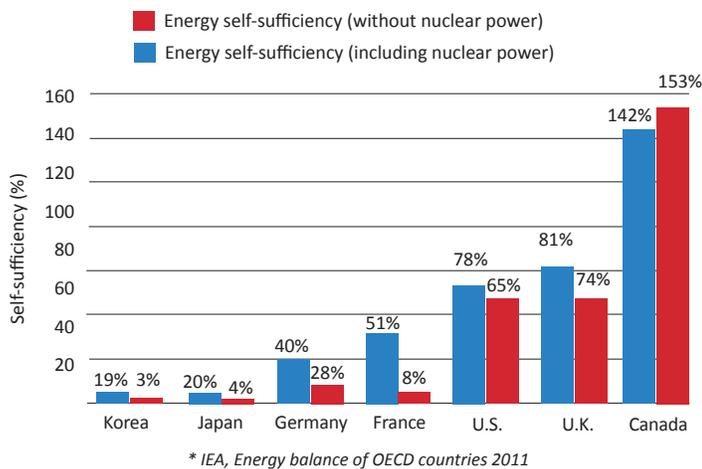


be the cheapest source of energy for Korea (See Figure 3, “Whole Sale Electricity Cost in Korea”). The country has also emerged as a major nuclear exporter that desires the ability to provide a full package of nuclear energy services in addition to reactors.

Moreover, South Korea is a responsible member of the international community, and argues that it has the *right* to enrich and pyroprocess based on Article IV of the Nuclear Non-Proliferation Treaty (NPT) to which the ROK is a Party, which states:

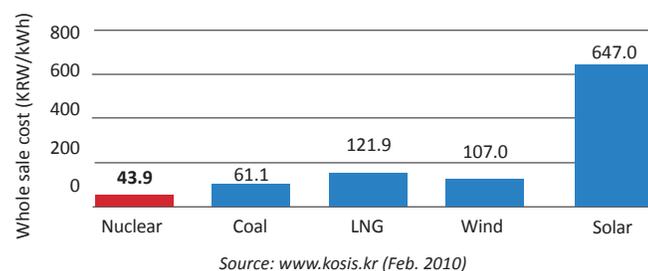
“Nothing in this Treaty shall be interpreted as affecting the inalienable right of all the Parties to the Treaty to develop research, production, and use of nuclear energy for peaceful purposes without discrimination and in conformity with Articles I and II of this Treaty.”

Figure 2: Korea’s Primary Energy Supply



The ROK is not only compliant with its nonproliferation obligations under the NPT but is also a party to a number of nonproliferation treaties, conventions and arrangements, including the Proliferation Security Initiative, the Global Initiative to Combat Nuclear Terrorism, and the Nuclear Suppliers Group. It has also ratified the Additional Protocol to its safeguards agreement with the IAEA giving the Agency more information about, and greater access to, Korean nuclear activities. Seoul also takes pride in the leadership role it has played in hosting the 2012 Nuclear Security Summit. In addition, Seoul is a strong ally of the United States, a factor of increasing strategic importance as the North Korean nuclear threat grows and as US policy “pivots” to Asia to counter-balance the rise of China. Given these credentials, Seoul takes the position that it should benefit from the same kind of treatment in the new US-ROK agreement enjoyed by EURATOM, Japan, and India in their nuclear cooperation with the United States.

Figure 3: Whole Sale Electricity Cost in Korea



**The Enrichment Debate**

South Korea does not currently possess an enrichment capacity and argues that it needs to be able to enrich uranium to: 1) enhance its energy security by reducing its reliance on foreign uranium enrichment suppliers that costs about \$300 million a year,<sup>3</sup> and 2) secure its competitiveness in overseas reactor sales. The basis for the latter argument is that buyers are increasingly demanding fuel assurances with their purchase of reactors. Thus, having an enrichment capability would allow Seoul to compete more effectively with Russia’s Rosatom and France’s Areva that currently provide a package of fuel cycle services.

The US response is that South Korea has no reason to be concerned about security of supply because: 1) there are several enrichment service suppliers that South Korea may call upon, 2) the international market for enrichment services has

India, and Japan. Its 23 nuclear reactors generate roughly 35 percent of the country’s electricity, and Seoul plans to build an additional 16 reactors by 2030 to meet its energy needs. (See Figure 1, “Current Status of ROK Nuclear Power Plants” and Figure 2 “Korea’s Primary Energy Supply”). Nuclear power has proven to



worked smoothly over the last five decades, and 3) consumers have suffered few disruptions of supply and those were for nonproliferation reasons. Thus, the US deems the security of supply argument as weak. In addition, many US experts believe South Korean officials may be overestimating the potential value of enrichment in selling reactors, citing market economics.<sup>4</sup> They argue that Seoul has more efficient alternatives to a national enrichment plant to meet its domestic needs for enrichment services and to promote reactor sales by providing ancillary enrichment services. The ROK could partner with an existing enrichment supplier, such as URENCO or the US Enrichment Corporation (USEC), to market its reactors. Seoul would, of course, not have access to the technology. Such arrangements not only increase South Korea's security of supply, but could be employed to supplement Korean reactor sales.

Moreover, the Korean demand for US consent to enrich US-supplied natural uranium supplied has little practical significance. The United States is not a major producer or exporter of natural uranium and the international market has a fairly large number of low-cost uranium producers. South Korea can and does import natural uranium from a number of different countries, including Australia and Canada. It may enrich these materials without Washington's approval. Although South Korea converts much of this uranium in the US, it does not need to since it can resort to other conversion suppliers, which therefore would not attract US consent rights to enrichment. Thus, South Korea would not need US consent to enrich uranium. However, it appears to be seeking US consent to enrichment since it would signal US political acknowledgment of a South Korean enrichment capability as acceptable from a nonproliferation point of view.

US resistance to giving this political endorsement is not the only obstacle that South Korea faces in obtaining a domestic enrichment capability. Seoul would either 1) have to undertake the formidable and costly task of building its own enrichment plant or 2) would have to find a country willing to transfer this technology to South Korea for either a national or multinational facility that could take up to fifteen years to construct. However, there is a strong consensus among enrichment technology holders<sup>5</sup> on the need to halt the further spread of national enrichment and reprocessing capabilities. The only transfers of this technology in recent years have been to countries that already possess an enrichment capability. The Nuclear Suppliers Group has adopted a strict new set of guidelines on the transfer of enrichment technology. For a variety of reasons, the few enrichment technology holders that exist – France, Russia, China, the US, and URENCO (a tripartite organization of the Netherlands, Germany and the UK) – are unlikely to be willing to provide such technology to South Korea, particularly in the face of US opposition.

Moreover, the fact that the US is not prepared at the present time to grant consent to Seoul to enrich uranium does not rule out the possibility that Washington would not approve it in the future if nonproliferation and economic circumstances were favorable to such a development.

For reasons mentioned above, US refusal to approve South Korean enrichment should not be a deal-breaker.

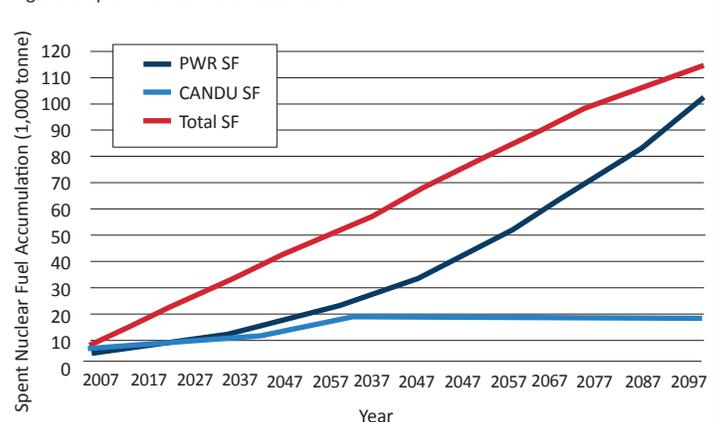
### The Pyroprocessing Debate

Resolving differences over pyroprocessing, however, may prove far more difficult. Like other reprocessing methods, pyroprocessing recovers plutonium, although in a mixture, for use in new nuclear fuel and diminishes the volume of nuclear waste that would need to be disposed.

Korean scientists argue that while pyroprocessing is in the experimental study phase and untested on a production or commercial scale, it is still critical to managing Korea's increasingly urgent spent fuel management problems. Their reasons are: 1) the absence of an adequate intermediate storage facility, 2) on-site storage will reach saturation in 2016, 3) the absence of an adequate geological repository to dispose used fuel, requiring about ten repositories the size of Finland's Olkiluoto, 4) the absence of an adequate measure to ensure the long-term safety of a repository over millions of years, and 5) it is a "bridge too far yet" to obtain support from the public and stakeholders for waste disposal.<sup>6</sup> Korea has forecast about 1,100 tons of spent fuel will be generated annually if and when all planned reactors are constructed (See Figure 4 "Spent Nuclear Fuel Accumulation").<sup>7</sup>

South Korea argues that pyroprocessing is more proliferation-resistant than classic PUREX reprocessing used by France, India, Japan and Russia that separates pure plutonium fully from the

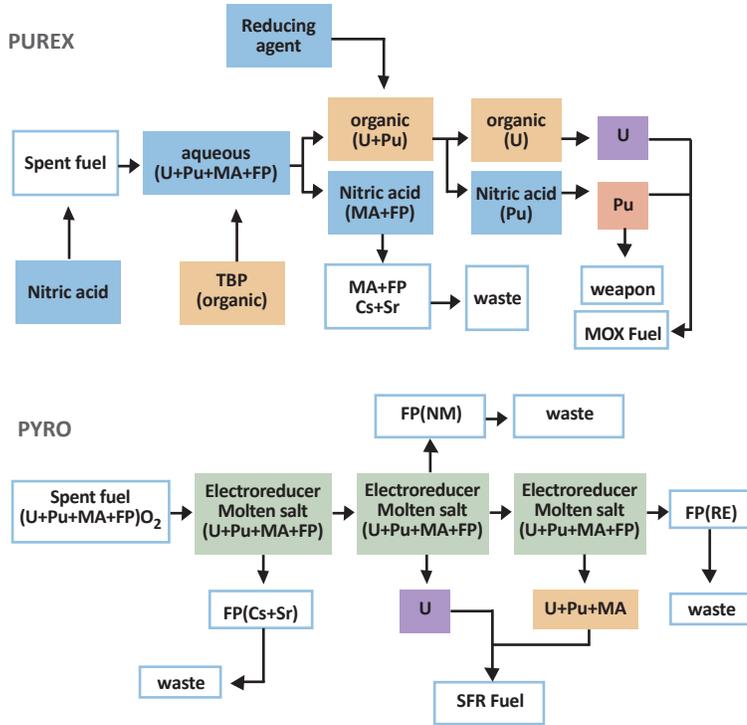
Figure 4: Spent Nuclear Fuel Accumulation



Source: ROK National Energy Basic Plan



Figure 5: PUREX vs. Pyroprocessing

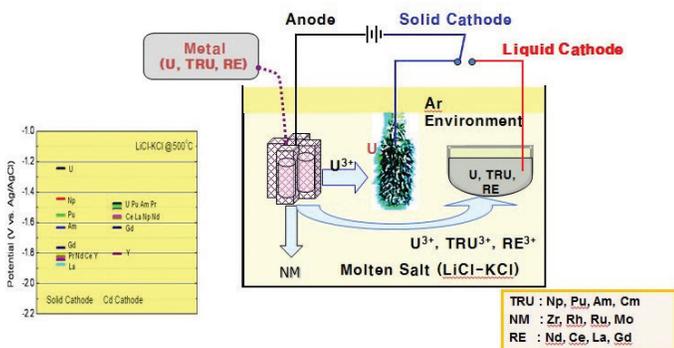


Source: Korea Atomic Energy Research Institute

By contrast, pyroprocessing yields a material that contains some radioactive fission products that makes it less suitable for nuclear weapons. In other words, plutonium is left in a reactor-usable mixture with uranium and other transuranic elements.<sup>8</sup> (See Figure 5 “PUREX vs. Pyroprocessing”). Scientists at the Korea Atomic Energy Research Institute (KAERI) argue that the type of pyroprocessing technology currently being developed with the US under a ten-year joint R&D study<sup>9</sup> is proliferation-resistant and cannot separate plutonium, unlike both PUREX and even the existing pyroprocessing technologies (See Figure 6 “Pyroprocessing Principle”).<sup>10</sup> They also believe it could reduce the volume and radioactivity of spent fuels while potentially allowing the used fuel to be recycled for further use.<sup>11</sup> South Korean scientists are thus reluctant to classify what they call a new method of pyroprocessing as reprocessing.

South Korea also believes that the US has sent conflicting signals on the issue of whether pyroprocessing is reprocessing, and whether it offers effective proliferation-resistance compared to traditional PUREX reprocessing. The two sides signed an R&D agreement on pyroprocessing in 2002 and South Korean scientists have participated in such joint experiments at US laboratories.<sup>12</sup> Some officials during the Bush Administration took the position that pyroprocessing is not as vulnerable to diversion to

Figure 6: Pyroprocessing Principle



- Put metal in anode basket, use solid cathode
- Applying current makes metal dissolve at anode and metal deposit at cathode
- After U recovered, use liquid Cd cathode
- Co-deposition of U, TRU, RE in Cd cathode

Source: Korea Atomic Energy Research Institute

a nuclear weapon as conventional PUREX reprocessing. However, the view that pyroprocessing is more proliferation-resistant than PUREX was not shared by all in the US government. The US Department of Energy (DOE) assessed a range of “proliferation resistant” technologies including pyroprocessing as part of its Global Nuclear Energy Partnership (GNEP) initiated by the George W. Bush Administration. In 2008, DOE released a draft Nonproliferation Impact Assessment (NPIA) of the GNEP Programmatic Alternatives that reached the preliminary conclusion that the candidate reprocessing technologies studied, including pyroprocessing, suggest only modest improvements in reducing proliferation risk over existing PUREX technologies, and these would reduce the risks that non-state actors, but not states, would be able to gain access to the plutonium.

As one US official put it in 2011, Washington concluded that pyroprocessing poses proliferation concerns because its key elements – electro-reduction and electro-refining – “have moved to the point that the product is dangerous from a proliferation point of view. So, for that reason, pyroprocessing is reprocessing, and that’s part of the problem. [DOE] states frankly and positively

highly radioactive nuclear waste, thus removing the key barrier to using the plutonium for nuclear weapons either by a state diverting the material or by a terrorist stealing the plutonium.



that pyroprocessing is reprocessing. Period. Full stop. [DOE] did not take that position five years ago when we started down the road of cooperation on pyroprocessing. Then the product was not weapons usable.”<sup>13</sup> Many American experts also believe pyroprocessing poses safeguards challenges and lacks effective mechanisms to detect the diversion of nuclear material.

The two countries also have different perspectives on their current ten-year joint feasibility study, as well as the economic feasibility and proliferation resistance of pyroprocessing. South Koreans believe that the assumption underlying the study was that if it produces economically efficient and proliferation-resistant pyroprocessing technology that deals with both the US’ and South Korea’s spent fuel problems, Seoul would be able to proceed to put in place a pyroprocessing capability at the commercial level. The Americans did not make any such assumption about future pyroprocessing. There are also differing views on what constitutes “economically feasible” pyroprocessing technology. Korean scientists argue that pyroprocessing is one of the most economic ways to manage the spent fuel problem, while most US experts believe that the once-through fuel cycle is less expensive than any kind of reprocessing and should provide adequate security of fuel supply for at least one hundred years, perhaps more.

Since Washington regards pyroprocessing as reprocessing, the US has been unwilling to justify an exception for South Korea to its long-standing policy of preventing the further spread of this sensitive nuclear technology. Washington believes that exempting Seoul from this policy would be controversial domestically, set a poor nonproliferation precedent, and spark regional and global nonproliferation concerns.

### North Korea and Strategic Context

The North Korean nuclear threat hovers over the negotiation of the US-ROK civil nuclear cooperation agreement. In 1992 the two Koreas signed a Joint Declaration in which they agreed not to possess either enrichment or reprocessing capabilities. Since then, North Korea has operated its reprocessing facility and constructed one or more enrichment facilities. It has also developed and tested nuclear weapons and missiles in defiance of UN Security Council resolutions. Pyongyang claims the 1992 Joint Statement is null.<sup>14</sup>

One could argue that North Korean actions have rendered the 1991 Joint Declaration meaningless and that Seoul should no longer be bound by it. However, Seoul has exercised restraint on this issue despite calls from within and outside the South Korean government to scrap the 1992 pact in the aftermath of continued

North Korean provocations. Moreover, the US clearly maintains that the existence of any reprocessing plant in the ROK would be inconsistent with the commitments Seoul made in the 1992 Joint Declaration.<sup>15</sup> In addition, a Six Party Talks agreement struck in September 2005 states that, “The 1992 Joint Declaration of the Denuclearization of the Korean Peninsula should be observed and implemented.”<sup>16</sup>

Despite US efforts to strike a sustainable deal with North Korea on dismantling its nuclear programs in return for a range of economic and security guarantees, Pyongyang continues to provoke the South, seems committed to continuing nuclear and missile tests in defiance of UN Security Council Resolutions, and now threatens that the US mainland is “well within” the range of its nuclear weapons. North Korea also regards itself as a nuclear weapons state, and prospects for the DPRK ever abandoning its nuclear programs are increasingly doubtful.

The DPRK’s nuclear weapons program has been and will continue to be a major source of instability on the Korean Peninsula until it is resolved. The US believes that persuading North Korea to dismantle its nuclear programs would be considerably more challenging if the South were to move toward acquiring enrichment or reprocessing capabilities.

### The US Congress: A Potential Wild Card

Some in Congress are taking a very tough stance on preventing the spread of nuclear weapons that may take the form of demanding future agreements contain a legal ban on enrichment and reprocessing by US nuclear trade partners. In 2009 the United States concluded a peaceful nuclear cooperation agreement with the United Arab Emirates (UAE) in which the UAE agreed to forswear the acquisition of enrichment and reprocessing capabilities, a condition that became known as the “gold standard.” There has been an on-going debate in Washington on whether the US should apply this gold standard to all future US peaceful nuclear cooperation agreements. However, we understand that the US is not pressing the ROK to renounce its rights to enrichment and reprocessing since Seoul has an advanced nuclear program, is compliant with its nonproliferation obligations, and is a close strategic ally. South Korea in any event seems highly unlikely to renounce what it regards as its sovereign right to such technologies as a Party to the NPT.

However, in 2011 the House Foreign Affairs Committee (HFAC) unanimously adopted legislation (H.R.1280) that, among other things, proposes to include the gold standard in all new agreements. In addition, the proposed legislation would change

the existing congressional review process by requiring that a new peaceful nuclear cooperation agreement could become effective only if both Houses of Congress cast an affirmative vote in its favor. However, the HFAC bill allows an exception if a new agreement contains the gold standard. New agreements that meet this condition would be subject to the current congressional review procedure that allows an agreement to enter into force after 90 days of continuous session unless Congress enacts a joint resolution of disapproval. The administration has raised strong objections<sup>17</sup> to H.R.1280, which died without a vote on the House floor. It is unclear whether an identical or similar bill will be introduced during this current session of Congress. Nevertheless, the views reflected in this bill may be important to the outcome of any congressional review of the new civil nuclear pact.

## Options

Given all these considerations, it is no surprise that Seoul and Washington have found it challenging to reach a mutual understanding on US approval of South Korea enrichment and/or pyroprocessing. The question then is what options are realistically available to the two parties to resolve their differences given the fast-approaching expiration of the existing agreement.

### Enrichment

The US is not likely to accommodate Korean demands for US consent to enrich US-origin natural uranium. As noted above, South Korea does not need such consent since it can and already does purchase less costly natural uranium from several other countries. Moreover, Seoul would face major economic and technical obstacles if it sought to build its own enrichment capacity despite the South Korean industry's impressive nuclear skills and capability. Enrichment technology holders are also unlikely to transfer enrichment technology to South Korea. Members of the Nuclear Suppliers Group recently adopted a new set of guidelines to govern the transfer of enrichment technology. Among other things they agreed to:

- "avoid, as far as practicable, the transfer of enabling design and manufacturing technology associated with such items; and
- seek from recipients an appropriate agreement to accept sensitive enrichment equipment, and enabling technologies, or an operable enrichment facility under conditions that do not permit or enable replication of the facilities."<sup>18</sup>

This is a so-called "black-box" condition. It is intended to limit an importer's access to the technologies and prevent the replication or reverse engineering of the technology.

"It is no surprise that Seoul and Washington have found it challenging to reach a mutual understanding on US approval of South Korean enrichment and/or pyroprocessing."

**Multinational, black-boxed enrichment plant.** Seoul might be quite amenable to establishing a multinational enrichment facility or a joint venture in Korea under black-box conditions. Proliferation risks could be reduced by placing any enrichment facility in South Korea under multinational or international auspices, and by implementing black-box controls. However, the US has not been an enthusiastic endorser of multinational enrichment plants, and some US experts doubt the effectiveness of black-boxing since it does not completely prevent the host state from acquiring information about centrifuge design and operation.<sup>19</sup> For example, centrifuges for the facility arrive in parts and are assembled on-site with operators having to understand how the centrifuges respond to variations in operating parameters. China is believed to have adopted Russian design details for its domestically made centrifuges after obtaining centrifuges from Russia on a black-box basis. In essence, some view the black box as more of a grey box.<sup>20</sup> Establishing a joint venture or multinational operation presents challenging management and operational problems that could affect the efficiency of any such operation. Finally as noted above, Seoul might find it difficult to find a technology holder to transfer such technology to South Korea even under black-box conditions. Still, the US and ROK could cooperate in R&D studies on multinational approaches to the fuel cycle.

For all reasons mentioned above, the most practical and most likely outcome of the negotiations may be that Seoul would go along with Washington's refusal to grant its approval to South Korea to enrich US natural uranium or to put its stamp of approval on a South Korean enrichment capability. The fact that South Korea would have a reciprocal right with respect to any nuclear material it exports to the United States might help make this outcome more politically palatable to Seoul. South Korea would still be able to avoid any concerns about security of supply by relying on a well-functioning international market in both uranium and enrichment services. Security of supply could be further addressed by US assurances that it would be prepared to give South Korea access to its national reserve of enriched uranium or support South Korean access to the IAEA nuclear fuel bank in the event of a supply disruption. Moreover, a US right to



consent to enrichment is not the same as a ban on enrichment and does not rule out the possibility that the Washington could give such consent at some time in the future if justified by nonproliferation and economic considerations. Finally, South Korea's joint ventures with existing enrichment suppliers could help the marketing of Korean reactors on the global market.

### **Spent Fuel Management Options**

South Korea clearly faces a legitimate, pressing problem in managing the spent fuel from its power reactors. Its current at-reactor storage capabilities will reach their saturation point in 2016. If the ROK government cannot resolve this problem soon, some of the power reactors may have to be shut down. But Seoul has a few options.

**Pyroprocessing.** Seoul claims pyroprocessing is the best way to manage its growing quantities of spent fuel, but pyroprocessing is not a realistic way forward, at least in the short term. Even if the ten-year US-Korea study due for completion in 2021 was to conclude that this technology is economically feasible and offers adequate proliferation resistance, Seoul could not build a commercial size pyroprocessing plant for at least two decades. Hence, even if the US were to consent to pyroprocessing in the text of the new agreement, it would not immediately solve South Korea's urgent spent fuel problem. Still, it would be prudent for the US and ROK to continue R&D on pyroprocessing as well as other potential technologies for managing South Korean spent fuel problems.

**Transfer spent fuel out of country.** One option that could provide near-term relief is to transfer some South Korean spent fuel to EURATOM for reprocessing. The ROK made informal inquiries with the US about this possibility in the 1990s, but the Clinton Administration quietly discouraged it. The ROK government is reportedly willing to revisit this question, and the US may now be more willing to consider third country reprocessing. In 2009 the US gave consent to the United Arab Emirates (UAE) to ship spent fuel subject to the US-UAE agreement to EURATOM for reprocessing. However, South Korean resort to this option is not without its problems. First, while France and the UK accept foreign spent fuel for reprocessing, both countries would require that the high-level waste as well as the recovered plutonium and uranium must be sent back to the ROK after reprocessing. Second, in granting its consent to Seoul to transfer spent fuel to EURATOM for reprocessing, the US would insist on retaining prior consent rights over any further disposition of the recovered plutonium and, for nonproliferation reasons, it is highly doubtful that the US would approve the retransfer of recovered plutonium from EURATOM back to South Korea. This would leave Seoul

with the dilemma of what to do with the recovered plutonium. The world is awash in this material because reprocessing in EURATOM, Russia, and Japan has continued, while its use as fuel in commercial power reactors in many countries has not kept pace. Thus, Korea could not find a market for its plutonium in Europe that the US would approve, and would be faced with the costly storage of this material. In addition, Seoul would find it difficult to take back its high-level waste from Europe because it has no available storage or disposal site.

A similar option would be to ship spent fuel to Russia. However, Russia takes back only used fuel produced from Russian supplied fuel. The US would have prior approval rights over such transfers and it is not clear whether the US would grant consent to such transfer. It is also unclear that Seoul would be politically comfortable in sending its spent fuel to Russia.

**Return of spent fuel to the US.** Washington could help Seoul's spent fuel problem by offering to take some of it back to the United States for storage and/or disposition. However this "cradle-to-grave" option is not realistic in the foreseeable future for several reasons. The US has no national waste program of its own and no place to put the spent fuel currently stored at its own reactors. Moreover, bringing back foreign spent fuel to the United States would face formidable legal and political obstacles, and Congress would have to approve any such take-back. Still, it makes good sense for Washington to begin exploring the possibility of taking spent nuclear fuel back from countries that do not have sensitive fuel-cycle facilities.<sup>21</sup> But such a policy will not come to fruition in the foreseeable future, if ever, and therefore offers no practical solution to South Korea's immediate problems of managing its spent fuel.

**Conditional consent.** The two sides could strive to reach agreement on a conditional consent arrangement on pyroprocessing. Under this option, South Korea would not be allowed to reprocess or alter in form or content US nuclear material until: 1) the joint study is completed so that South Korea would not engage in pyroprocessing for at least ten years, and 2) based on the study, both sides would conclude that pyroprocessing is economically feasible and affords adequate proliferation resistance. In addition, the US would have to insist that it retain the right to determine whether South Korean pyroprocessing of US nuclear material meets US statutory standards. Section 131 of the AEA stipulates that prior to approving any requests for reprocessing, the Secretary of Energy must determine that the proposed consent "will not be inimical to the common defense and security" of the United States and "will not result in a significant increase in the risk of proliferation" beyond that which exists at the time the



approval is requested.<sup>22</sup> Among the factors that the Secretary of Energy and the Secretary of State must consider in making this judgment is whether or not the reprocessing or retransfer will take place under conditions that will ensure “timely warning” to the United States of any diversion well in advance of the time at which a nuclear weapon state could transform the diverted material into a nuclear explosive device.

South Korean negotiators may find it very difficult to accept any conditional consent arrangement that gives the US the unilateral degree of discretion that the US side believes it needs to meet its own legal requirements. Seoul would quite understandably seek greater predictability and certainty in any conditional consent arrangement, and strive to define a set of precise criteria that, if met, would allow it to proceed with some pyroprocessing, preferably on a long-term, programmatic basis for the life of the agreement, or at least proceed with some further development of the technology perhaps with the construction and operation of a pilot facility on a trial basis.

Given its statutory requirements, the US will have to resist accepting any specific set of conditions that, if met, would be sufficient for US consent to South Korean pyroprocessing. Rather, Washington is likely to insist on considerable leeway in deciding whether approving the ROK pyroprocessing “will not be inimical to the common defense and security” and “will not result in a significant increase in the risk of proliferation.” Among other factors that will influence such a determination are: 1) how it would affect efforts to denuclearize the North, 2) the status of the North Korean nuclear program, 3) whether it would have an adverse effect on broad US interests in preventing the spread of enrichment and reprocessing, and 4) its impact on regional and global stability.

Agreeing on language on a conditional consent basis may prove difficult for both sides, but it may be the only way forward on the pyroprocessing issue. In the meantime, South Korea will have to find some way to store its spent fuel on an interim basis.

### Dash to the Finish Line

Given the strong differences of views between the ROK and the US over enrichment and reprocessing, it will be a monumental challenge to reach agreement on a text and to submit it to their respective legislatures for review and approval before the March 2014 expiration date. In the case of the United States, the AEA requires a proposed agreement lie before Congress for ninety days of continuous session before it may enter into effect. Given the Congressional calendar, this could take six or seven months. Therefore, the new agreement realistically should be submitted

to Congress by spring or early summer of this year. This will be an extremely challenging schedule for the United States to meet. Once the two sides agree to a text on an ad referendum basis, the executive branch by law must prepare extensive documentation in support of the agreement, including: 1) a nonproliferation assessment statement, 2) the secretaries of State and Energy must recommend the agreement to the president for his approval, and 3) the independent Nuclear Regulatory Commission must provide the president its views on the agreement. Then the president must approve the text for signature, and the two governments must sign the text. Only after all these steps are completed may the proposed agreement be submitted to Congress for its review. These various steps take considerable coordination and time to complete. There may simply be insufficient time to conclude the negotiations and prepare the required documentation in the coming months. The two sides are facing the real prospect that the agreement may lapse without a new agreement in place.

While the Park Geun-hye administration that took office on February 25th is expected to maintain a position similar to the Lee Myung-bak administration on the US-ROK nuclear trade pact, it is unclear what exact conditions it will find acceptable. Thus, the change of administration may delay the negotiations.

Given the challenges of the calendar, the US and South Korea realistically have only a few options:

**Lobby for an affirmative congressional approval.** Given the positions of the two sides, it may be difficult to reach an understanding on these issues by spring or summer of this year. However, if the two sides manage to reach agreement but not in time to meet the ninety-day legislative review period before the existing agreement expires in March 2014, the US administration could lobby Congress to pass a resolution of approval so that a lapse could be avoided. However, this increases the risk that some members of Congress could seek to add conditions to the approval of the agreement that would be unacceptable to either the US administration or the South Korean government. As noted, some in Congress believe the US should require all future cooperating partners, including South Korea, agree to a legal commitment to abstain from acquiring any enrichment or reprocessing capability. Proponents of the gold standard might vote against any new agreement that does not contain this provision, thus risking disapproval of the new US-ROK peaceful nuclear cooperation. In any event, persuading Congress to vote on the new agreement before the existing one expires would require a major lobbying effort by the administration.



**Allow the agreement to lapse for a short period.** The likelihood of a lapsed agreement currently appears greater than expected with both parties firm in their respective positions on enrichment and pyroprocessing.

The economic consequences of such a lapse are uncertain for both countries. The United Nations Commodity Trade Statistics Database (Comtrade) estimates US exports to Korea of nuclear components and fuel elements at \$818.8 million between 2001 and 2010, while large exports under licenses such as reactors and major components are estimated up to \$200 million apiece.<sup>23</sup> Korean officials have been unable to confirm or accurately track the value of US imports dependent on the renewal of the US-ROK agreement. However, the \$20 billion contract for Seoul to provide reactors to the UAE would be threatened by a lapsed agreement. Roughly \$2 billion of work on the UAE Barakah plant is expected to go US companies while some US components and subcomponents need to be exported to Korea for further fabrication before shipping to the UAE.<sup>24</sup>

However, the economic effects of a short-term lapse are not likely to be significant for two reasons. First, the US-EURATOM agreement lapsed only for a couple of months without any significant economic or political fallout. Anticipating a lapse, US companies took steps to obtain the relevant export licenses and approvals well in advance of the expiration date of the agreement and thus avoided significant disruptions in trade. American and Korean companies could do the same in the event of a likely lapse of their agreement. Second, the Atomic Energy Act requires an agreement for cooperation only for the export of nuclear material, nuclear facilities and their major components (in the case of reactors—the pressure vessel, the complete control rod system, the primary coolant pump, fuel charging, and discharging machines). The US does not manufacture the last item, and all other nuclear components and substances may be exported without an agreement, provided the ROK gives the US appropriate nonproliferation assurances. Under the AEA and existing Department of Energy regulations, US technology may be exported outside an agreement for cooperation. The export of any nuclear technology to a specified list of countries requires specific authorization of the Secretary of Energy. However, South Korea is not on that list, and most technologies may be exported under general license to the ROK. Only sensitive nuclear technology (SNT) to the ROK would require a DOE approval, and the US as a matter of policy does not export SNT.<sup>25</sup> Hence some nuclear trade may legally continue in the absence of an agreement. However, it is not clear that the US would be willing to issue licenses or approvals in the absence of an agreement.

However, a lengthy lapse could have adverse economic and political consequences. The South Korean industry could lose confidence in the US as a reliable supplier and turn to other partners. Politically, a lengthy lapse would show that the two close allies cannot agree on the important subject of their nuclear cooperation. The US-ROK alliance has never been stronger as it was during the Barack Obama-Lee Myung-bak administrations. However, both presidents postponed settling some of the most complex and sensitive bilateral issues for their successors. It is now up to Presidents Obama and Park Geun-hye to settle other outstanding issues without straining the alliance. Top security issues include the transfer of OPCON (operational command), defense cost burden sharing amid fiscal constraints in both countries, the relocation of US bases within Korea, and the North Korean threat. Both sides will want to avoid a repeat of the beef issue that ignited anti-American sentiment in South Korea and will not want to add civil nuclear trade to the list of unsettled issues. Failure to come to closure on a peaceful nuclear trade pact may lead to South Korean public criticism of the alliance.

**Short-term extension of the existing agreement.** The two sides could agree to try to extend the current agreement for a specified period of time, such as two or three years or perhaps until the joint study is completed in ten years. This option would give both sides more time to reach agreement on the enrichment and pyroprocessing issues.

However, this course of action carries considerable risk. Since the existing US-ROK agreement does not meet all the requirements of the Atomic Energy Act for a peaceful nuclear cooperation agreement, the agreement may not enter into effect after the US president has submitted it to Congress for a ninety legislative day review. Rather, approval of the agreement would require an affirmative vote by both houses of Congress. It is proving increasingly difficult to pass important issues through Congress, and it is questionable whether both Houses would take a vote on a timely basis. Even in the event of a timely vote, this option would run the same risks noted above of Congress possibly seeking to add conditions onto the approval of the agreement that would be unacceptable to either the US executive branch or the South Korean government. This option would require a major lobbying effort by the administration.

## Conclusions

A new bilateral peaceful nuclear cooperation agreement offers the potential for strengthening the ROK-US nuclear partnership and could open up new avenues of collaboration such as combining Korea's nuclear manufacturing and construction abilities with US technology, and global marketing outreach aimed at strengthening



joint competitiveness in the global nuclear market that is currently dominated by France and Russia.<sup>26</sup>

To realize this potential, the two sides will have to resolve their differences over the enrichment and pyroprocessing issues. This will require acknowledgment of the political sensitivities and legal requirements of both countries. South Korea views its existing relationship with the US as one-sided and giving the US unilateral control over its civil nuclear program. It also sees the US policy as discriminatory compared to Washington's treatment of Japan and India. In addition, Seoul believes that the US needs to implement the current "strategic alliance" declared by then President Lee

Myung-bak and President Barack Obama in 2009.<sup>27</sup> On the other hand, Seoul has to recognize US nonproliferation priorities, America's strict legal requirements for approving sensitive nuclear activities, its concerns about setting a damaging nonproliferation precedent, and the implications of a new US-ROK civil nuclear trade pact for denuclearizing North Korea.

None of these options discussed here are ideal. All have real costs and risks, but the two sides need to move quickly in deciding how they wish to work their way out of the political thicket, avoid the political and economic costs of failure, and come to a timely closure on a new peaceful nuclear trade pact.

## Endnotes

- <sup>1</sup> Consent rights can be granted in two ways: 1) in the agreement itself, as done in the Japan and EURATOM agreements, or 2) after the agreement enters into force in what is called a subsequent arrangement. The US has given its consent to reprocessing in agreements with EURATOM and Japan, and through the subsequent arrangements process with Japan and India.
- <sup>2</sup> Nuclear Nonproliferation Act of 1978: Congress laid out nine conditions, including an assurance of peaceful non-explosive use, safeguards for non-nuclear-weapon states, safeguards in perpetuity, an assurance of physical protection, and consent rights over enrichment, reprocessing and alteration of nuclear material subject to the agreement. All of these conditions must apply to any transfer of sensitive nuclear technology (enrichment and reprocessing).
- <sup>3</sup> Seongho Sheen, "Nuclear Sovereignty versus Nuclear Security: Renewing the ROK-US Atomic Energy Agreement," *Korea Journal of Defense Analysis*, Vol. 23, No. 2, June 2011, pp. 273-288.
- <sup>4</sup> Miles A. Pomper, "How to Unsnag US-South Korea Nuclear Negotiations," *Bulletin of the Atomic Scientists*, 25 September 2012.
- <sup>5</sup> Fred McGoldrick, "New US-ROK Peaceful Nuclear Cooperation Agreement: A Precedent for a New Global Nuclear Architecture," Center for US-Korea Policy, Asia Foundation, November 2009.
- <sup>6</sup> Lee Han-soo, "Advanced Fuel Cycle Pyroprocessing Technology," 1 February 2013.
- <sup>7</sup> Park Seong-won, "Why South Korea Needs Pyroprocessing," *Bulletin of the Atomic Scientists*, 26 October 2009.
- <sup>8</sup> KAERI scientists.
- <sup>9</sup> The US and ROK agreed in 2011 to conduct a 10-year Joint Fuel Cycle study on spent fuel management options including pyroprocessing in parallel negotiations on the US-ROK nuclear cooperation agreement.
- <sup>10</sup> H.D. Kim, H.S. Shin, D.Y. Song, T.H. Lee, B.Y. Han, S.K. Ahn, and S.H. Park, "Application of Safeguards-By-Design for the Pyroprocessing Facilities in the ROK," *Journal of Nuclear Materials Management*, Summer 2012, Volume XL, No. 4.
- <sup>11</sup> Ibid.
- <sup>12</sup> The US agreed to such R&D level cooperation on a case-by-case basis. South Korean scientists were restricted from using natural uranium, which not contain plutonium and from "hot" processing of used nuclear fuel on Korean soil.
- <sup>13</sup> Richard Stratford, U.S. Department of State, deputy chief negotiator, panel remarks at the 2011 Carnegie International Nuclear Policy Conference, 29 March 2011.
- <sup>14</sup> North Korea's state-run KCNA report, January 25, 2013.
- <sup>15</sup> Pre-Hearing Questions for the Record, Senator Richard Lugar Nomination of Helen M. Tauscher to be Under Secretary of State for Arms Control and International Security, <http://Lugar.senate.gov>.
- <sup>16</sup> At the time, North Korea's HEU activities were not officially confirmed, and one way to deal with HEU suspicions was to include the 1992 South-North joint declaration clause in the September 2005 Six Party Joint Statement.
- <sup>17</sup> State Department Fact Sheet, July 15, 2011: "The United States' ability to use 123 Agreements to strengthen nonproliferation conditions in global nuclear commerce would therefore be significantly diminished, while at the same time the U.S. nuclear industry's ability to be a major player in global civil nuclear cooperation in the future would be crippled, resulting in the loss of potential American jobs... as H.R. 1280 would also require that every 'subsequent arrangement' under a 123 Agreement be approved by affirmative action by Congress, it would severely restrict the movement of nuclear material between countries, as well as the conduct of other routine nuclear commerce, under existing 123 Agreements."
- <sup>18</sup> IAEA document INF/CIRC/254/Rev.10, Part 1.



- <sup>19</sup> Scott Kemp, remarks at “Fuel Cycle Policy and Fuel Supply Assurance: Opportunities and Challenges to Collaboration,” GABI-KAIST Nuclear Energy Workshop, Washington, DC, 9 November 2012.
- <sup>20</sup> Ibid.
- <sup>21</sup> Ellen Tauscher, “Addressing the Nuclear Fuel Cycle: Internationalizing Enrichment Services and Solving the Problem of Spent-Fuel Storage,” *Multinational Approaches to the Nuclear Fuel Cycle*, American Academy of Arts & Sciences, 2010.
- <sup>22</sup> See Section 131 of the Atomic Energy Act
- <sup>23</sup> Mark Holt, “US and South Korean Cooperation in the World Nuclear Energy Market: Major Policy Considerations,” 28 January 2013.
- <sup>24</sup> Ibid.
- <sup>25</sup> This situation could change. DOE is presently considering amending its regulations on technology to require that only countries with an agreement for cooperation in effect with the United States would be eligible for a general license. All others would require a specific authorization from the Secretary of Energy.
- <sup>26</sup> Jun Bong-geun, “The ROK-US Nuclear Partnership for the Peaceful Use and Nonproliferation,” EAI-CSIS Workshop on US-ROK Cooperation for Global Nuclear Governance, 16 November 2012.
- <sup>27</sup> June 16, 2009 US-ROK Joint Vision: “We aim to make low-carbon green growth into a new engine for sustainable economic prosperity and will closely cooperate in this regard. We will strengthen civil space cooperation, and work closely together on clean energy research and the peaceful uses of nuclear energy,” A similar agreement was reached on August 6, 2008 between then Presidents George W. Bush and Lee Myung-bak.

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