Assessing North Korea’s Nuclear Weapons Capability

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by Lee Chun-keun

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For the Korean language version of this report click here.

I. Introduction

Lee Chun-keun writes that ‘North Korea, after decades of effort in its nuclear endeavor, has managed to develop its nuclear program using homegrown resources.’ He states that while North

Korea’s ‘nuclear weapons program…lacks parts, resources and technology to support it, the country, based on its philosophy of self-reliance, has in part overcome these obstacles.’ In light of North Korea’s nuclear weapons development, Lee argues that ‘We need to initiate a much deeper study into the North's nuclear-related technology.’

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II. Special Report by Lee Chun-keun

Assessing North Korea’s Nuclear Weapons Capability

North Korea's nuclear weapons capability has grown consistently by conducting three nuclear experiments and the country has announced that it has tested small and light-weight nuclear warhead during its latest experiment. It suggests that the North is in possession of a small nuclear warhead that can be mounted on missiles. The country, by revealing its large-scale uranium enrichment facility, boasted that it can raise its nuclear storage capacity by vast amounts. Now it is declaring, by mentioning a new type of atomic experiment, its development of a much more advanced nuclear weaponry.

But the reading of the North Korean nuclear weapons situation by neighboring countries is varied, according their key interests and understanding of North Korea. The U.S. interest in international security and nonproliferation is strong and South Korea sees denuclearization, inter-Korean cooperation and unification as key policy issues. China puts emphasis on border security, increasing it’s regional influence, North Korea's regime stability and economic recovery and resolving of its energy crisis. Regional players sometimes misunderstand the North's true intentions and stumble in drawing up measures.

A closer and more intricate examination into North Korea is needed to avoid these pitfalls. The history and assessment of the North's nuclear program is revisited by examining the history of the country's science technology and education, as well as its national research development plan and foreign cooperation in areas of science and technology. This would eliminate any unnecessary debate and provide a detailed forecast of future developments. Even though the results do not drastically differ from the current on-going ones, a more objective observation can be made from inductive analysis.

The history and development of the North Korea's nuclear program

1) Japanese and Soviet influence

The history of North Korea's nuclear weapons program reaches way back to the Japanese colonial period. Japan's Institute of Natural Science and Chemistry, Riken, discovered a rare earth resource mineral in the current North Korean region. Analysis revealed that about 4-5% of the content was uranium oxide. By the time World War II came to a close, Japan had produced several tons of the mineral and was about to deliver it out of Korea through Incheon. The U.S. military government confiscated the minerals, questioned those concerned and wrote up a top-secret report on Japan's nuclear research. This paper was declassified a few years ago and made public.[1]

The graphite electrode plant built by a Japanese company in the Hamgyong province during the colonial era also influenced North Korea's nuclear development. The Noguchi business group grew successful by developing and excavating quality graphite mines, and by manufacturing goods out of them through state-of-the art production plants. The groundwork for the development of a graphite moderated reactor using North Korea's natural uranium and graphite was laid during this period.

The Soviet Union, which was in competition with the U.S. during the Cold War, also showed keen interest in North Korean uranium. Aircraft-based uranium resource exploration, its development and exports were key areas in North Korea and the Soviet's technical cooperation. Kim Il-sung had also emphasized many times the importance of earning foreign exchange by resource development and its shipments to the Soviet Union. This served as momentum for North Korea to send scientists to the Soviet-led UINR and the nation's interest in building nuclear related research and facilities.

2) 1950-1960s : Forming the groundwork

North Korea's nuclear development began speeding up in the mid 1950s. Kim Il-sung in 1952, in the midst of war, constructed the country's Institute of Science. In the mid 1950s, some three years after post-war recovery, Kim ordered the development of basic nuclear research and manpower. In 1955, a nuclear physics course was set up at the Kim Il Sung University's college of physics and a year later a nuclear physics lab opened up in the Institute of Science's mathematical physics institute. North Korea, around this time, sent an extensive number of researchers to the Soviet Union and East Europe for overseas studies. [2]

Nuclear technology surfaced as one of the core tasks in the state’s overall science technology blueprint. This was due to the face that nuclear power was recognized as being critical to both military and energy issues. North Korea’s ‘10-year science development plan’, which first began in 1957, included the research and development of nation-wide underground resources, including uranium. As ties with the Soviet Union withered in the 1960s, the plan ended up not being properly fulfilled. But an extensive investigation of the country’s resources was undertaken as planned.

This was also when the country’s first nuclear reactor was built. The IRT-2000, which used enriched uranium as fuel, was constructed in Yongbyon through cooperation with the Soviet Union. The reactor entered operation in 1965, thus allowing a balanced development of the country’s nuclear research, personnel training and applied uses. As the Korean peninsula’s security situation turned for the worse, Pyongyang established its Military Science Research Institute to embark on high-powered weaponry.

3) 1970s : Establishing the self-reliant nuclear fuel cycle

In the 1970s the world was struck by a global oil crisis. North Korea, whose energy policy centered around coal energy, further strengthened its domestic-based energy initiatives in the midst the overseas energy crisis. Kim Il-sung pushed for a stronger domestic-based energy supply and procurement policy. The country also started examining ways to use its abundant uranium and graphite.

The North’s science and technology circles in the 1970s, like other fields, also entered a ‘test of ideology’ phase amid the country’s establishment of the ‘Monolithic Ideology System of Kim Il Sung’ and the ‘August 18 Axe murder’ incident. Many scholars and professors in the state research labs and universities were demoted and exiled to regional labor sites. Then the supreme leader’s commands were the ultimate goal that had to be carried out and executed without question. The North then formed the ‘Juche Science Technology Revolution Theory’ and refocused the country’s core research projects from that of basic studies to a more production-based applied ones.

Around this time the country began educating and cultivating highly-skilled scientists to initiate full-scale nuclear development. Newly established in Kim Il Sung University's school of physics were majors in nuclear physics, chemistry and radiation chemistry. In the Kimchaek University of Technology, a college of nuclear physics was set up fresh, housing majors in nuclear materials, nuclear engineering, nuclear reactor, physical engineering and applied mathematics. The number of graduates in nuclear studies soared.

This was also when a plethora of nuclear-related books were published. Most were translation works of existing foreign works, but the government's effort to acquire massive number of books to strengthen its level of nuclear academia and researchers was worth noting. The country joined the IAEA in 1974 to enter a more systematic growth and research of its nuclear program.

4) Early-mid 1980s: From research to production

In the 1980s, North Korea's national economy became paralyzed following it energy crisis. The economic gap between the two Koreas also widened substantially. The fallout/reform of socialist countries led Kim Il-sung to seriously consider the future path of the country. Apparently, this was around when the country began using nuclear power not only to power the country but to develop nuclear weaponry. The North, at the 1981 national scientists convention, stressed the importance of nuclear power using homegrown resources. It greatly strengthened research and manpower cultivation.

The country, around this time separated its nuclear development program into basic and applied divisions. Most of the applied branch was moved to Yongbyon. Nuclear-related curriculum at Kimchaek University of Technology was revamped extensively. Within the college of nuclear studies, majors in nuclear material and nuclear physics were retained while other majors — applied mathematics, nuclear engineering — were relocated to basic undergraduate studies. Overseas studies programs were also expanded.

Nuclear research was also divided into to basic and applied branches. Yongbyon was further geared towards applied studies. Noteworthy of the country's two '3-year science technology development plans' were the inclusions of developments of uranium enrichment and fast-breeder reactors using lasers and chemical exchange processes, the reprocessing of used nuclear fuel and processing/handling of nuclear waste. Such programs in the socialist country are as effective as law and there is little doubt of their actual execution.

Uranium enrichment research using lasers seems to have been conducted in a natural sciences college under the national science research institute in Pyongsong. This particular college housed a laser instrument that was provided by the Chinese science circle. North Korea seems to have been unsuccessful in mass producing this laser equipment. From the late 1980s, nuclear studies continued to appear in the country's state research and development plans. This, as will be mentioned later, appears to be due to the Yongbyong region as a whole being realigned as part of the military's munitions division. All of studies most likely were prioritized for military use. Related studies became classified as the country's nuclear weapons research pushed further forward.

5) Mid to late1980s: From energy to weapons

Following national efforts, North Korea succeeded in developing the UF6 production process, which is the pre-enrichment phase. In 1986, it began operations of the 5MWe nuclear reactor and later entered partial operations of the radiochemistry lab, a reprocessing facility.

Following the construction of reactor in Yongbyon, full-fledged nuclear arms development began.

The command agency was first realigned. The nuclear research institute, which was later reorganized into the nuclear committee, was again expanded into the ministry of nuclear industry, becoming a government body overseeing part of the country's nuclear industry. It was later brought under the ruling party's military munitions division, which oversaw the Yongbyon area's arms research and development.

Related education and other agencies were also expanded. The Physics Institution, which was established in 1980 for the education of researchers' reeducation and their childrens' schooling, was enlarged into the Yongbyon Physics Junior College in late 1980s that included a doctoral program. Information pertinent to the college, being a part of the military, was shrouded in secrecy and those from other regions did not know the existence of this place nor were eligible for entry.

The college housed three undergraduate schools, with a total of 10 majors. Among these, three were dubbed the 'elite course' dedicated to gifted students, while the reactor engineering major was a 3.5-year vocational course. Another consisted of a 4.5-year program that included six months of military training. All students received on-the-job training at Yongbyon's production and research facilities. Most of the final semester was spent in the field.

Weapons research was also conducted in and out of Yongybyon. According the Seoul defense ministry, some 70 high explosive tests were conducted. Tests on finalized detonation device were also carried out between 1993 and 1998. The country ended up testing its first atomic explosion in the Mantop Mountain regions on October 9, 2006. It was the first pre-announced nuclear test. It included the timing and the power of the experiment. Chinese researchers saw this as the manifestation of the North's confidence.

6) Halt in disablement

We can reexamine the North's disablement process following the agreement sealed on February 13, 2007. Related parties saw the suspension of plutonium production as the most pressing matter. Through negotiation, the parties achieved the suspensions of fuel processing, reactor and reprocessing facilities. Added to this was the suspension of uranium enrichment using centrifuge and exports to Syria and other rogue nations.

Prioritizing half of plutonium was then the most rational choice and the process for some time went fairly smoothly. Following the disablement process, the parties negotiated additional steps, such as extracting Pu stocks and used nuclear fuel, dismantling of nuclear arms and test facilities and the termination of the IRT-2000 reactor.

The good start, however, proved not to be sufficient. Six months after the North announced that it was disabling its nuclear facilities, it restarted the 5MWe reactor. Despite the facility being worn down, it was possible to produce additional weapons-grade Pu. Signs were detected recently of a possible reopening of the North's radiochemistry laboratory. This signals the additional reprocessing of reactor-produced Pu.

7) Uranium enrichment

The North Korean nuclear crisis entered a new phase, as the country's foreign ministry issued a statement on April 2009 hinting that it was enriching uranium and the state officially confirmed it in June. The issue, which first surfaced during U.S. special envoy Kelly's visit to Pyongyang on 2002, became a critical development.

Uranium enrichment on North Korean documentations first appeared around the late 1980s. The country included the completion of a nuclear fuel cycle in the 1st and 2nd ‘3-year science technology development plan’ and embarked on developing core technologies through enrichment using lasers, reprocessing of used nuclear fuel and disposal of nuclear wastes.

The state science technology development plan stands effective as any law. Therefore agencies and responsible scientists must carry out the plan and report on the results. The undisclosed, military area within the blueprint is suspected to have included development of applied nuclear weaponry.

This is also seen within the annals of the North’s overseas science cooperation. In the 1990s, the Chinese Science Institute and the North Korean Science Institute’s mechanical engineering lab conducted joint research into a high-speed centrifuge for biology use. The lab was North Korea’s finest research facility but had received Chinese samples due to a lack of domestic resources. The joint study was suspended after an explosion accident during an experiment.

Pakistan also reportedly provided 20 P1 centrifuges and schematics for the P2, as well as a tour of their facilities. North Korea reportedly imported 150 tons of high-strength aluminum, enough to build 2,600 centrifuges. Many experts back then, however, saw the aluminum imports as parts for the outer casing of the P-2 centrifuge. Experts believed that the North was not capable of producing the steel used in the rotor. North Korea was seen as having faced an obstacle in its centrifuge development. The country, however, showed American scientist Dr. Hecker in November of 2010 its massive uranium enrichment facility housing 2,000 centrifuges.

North Korea's nuclear capability

1) Completion of self-reliant nuclear fuel cycle

North Korea's nuclear weapon development capability currently stands as follows. First, the country, using its own raw materials, succeeded in completing a self-circulating nuclear fuel cycle. It possesses over 20 million tons of uranium resources and is capable of producing 2.9 million tons worth of yellow cake using the refining facility.

The yellow cake is transferred to the Yongbyon nuclear fuel production plant and is converted to uranium metal. Its later turned into aluminium alloy then inserted into the magnox jacket crown to be used as the reactor's nuclear fuel rod. The Yongbyon facility is reported to have a capacity to produce 100 tons of uranium fuel rods annually, which is equivalent to two 5MWe reactors.

There are currently 2 reactors operating in Yongbyon. The 50MWe and 200MWe reactors were suspended since the Geneva framework agreement and is currently unsalvageable. The IRT-2000, provided by the Soviet Union, began operations in 1965. It had an initial output of 2MWt but the North upgraded it up to 8MWt. The country uses it for isotope production and research. It uses a small amount of highly-concentrated uranium for fuel.

The graphite moderated reactor, central to the weapons-grade Pu production, was built in 1986. It was operational until April of 1994 and later went through several shutdowns and reopenings over international sanctions. Its cooling tower was blasted as part of its disablement procedure. The North, however, has resumed low-output operations. When equipped with 8,000 nuclear fuel rods, it can process about 6~7 kg of weapons-grade Pu in about a year. This is close to the amount of a single nuclear weapon. The country has reportedly produced about 44~50 kg at the most. This is equivalent to some 6~10 nuclear arms.

Spent nuclear fuels are sent to a plant known as a radiation chemical lab. They’re reprocessed and extracted of nuclear arms Pu. The plant reportedly is capable of processing 5MWe reactor in about

100 days. This plant houses a production line for metallic Pu.

2) Construction of a new reactor

Unlike previous graphite moderated reactors, there are new light-water reactors being newly built. North Korea on November 2010, showed to Dr. Hecker its uranium enrichment facilities along with its light-water reactor. The country showed off the facility as proof of its possession of uranium enrichment facilities.

The North said that the reactor was designed with a 100MWt heat output and a 30% heat efficiency. Dr. Hecker estimated that its power output stood at around 25~30MWe. The reactor is reportedly made via homegrown technology, with self-produced low-density uranium used as nuclear fuel.

The remaining facilities and technology the North must procure amid a lack of international support and use of a different type of reactor. The country is known to have developed a UO2-type nuclear fuel and use cover material made using zirconium alloy or stainless steel. Operational details are as yet unknown. A reactor must have facilities and manpower that can tailor and support high temperature and high pressure. It remains to be seen whether the North can successfully build and operate such technology and facility.

David Albright of the ISIS asserted that the reactor can be used in producing weapons-grade Pu. He believed that with full optimization, the reactor can produce 20 kg of weapons-grade Pu a year. This amounts to about three nuclear weapons. The North has begun production of enriched uranium and is capable of reforming the reprocessing plant to also process spent nuclear fuel.

3) Large scale development of a nuclear workforce

North Korea is believed to have produced 7,000 nuclear expert-level personnel and 3,000 nuclear researchers. This can be deduced from the following. The Kim Il Sung University, since the 1950s produced 10 experts a year for 20 years. Since 1973, it has produced 60 a year for over 40 years. This adds up to a total of 2,600. Given the Kim Chaeil university, while the number of its majors graduated, ran 5 majors, it likely produced about 2,800 experts.

We can deduce about 3,000 additional nuclear knowledge endowed individuals from other educational agencies. The total rises to 8,000. But we must consider the retirees. The mostly highly-trained staff that spent time overseas probably stands at around 250-300. The number of real core personnel involved in nuclear arms is estimated to stand at around 300.

Table 1 shows the majors at the Yongbyon Physics Junior College. There are 10 majors or courses within the schools of nuclear material, nuclear electricity and nuclear energy. Among these, three are known as the 'elite course.' The reactor engineering course is a 3.5-year technical college course. Other majors are 4.5-years long and include six months of military training.

Table 1 Yongbyon Physics Junior College's education program

College	Major	College	Major

Nuclear material	Nuclear material	Nuclear energy	Reactor(3.5 years)
	Nuclear material (elite course)		Reactor
	Nuclear chemistry		Reactor (elite course)
Nuclear electricity	Nuclear measurement		Molecular physics
	Nuclear process		
	Nuclear process (elite course)		

Those enrolling in the elite course go straight to college, without entering the military, after graduating from highschool. Having elite courses in all three colleges show how much the North puts emphasis in Yongbyon. All education bodies here utilize the entire Yongbyon region as a training facility. The final semesters are on-the-job training. The country is basically self-cultivating its nuclear related manpower in Yongbyon.

4) Centrifuge production, uranium enrichment

The North's uranium enrichment capability has gained some attention amid the revelation of its enrichment facility to Hecker. The North, in fact, has accumulated quite a lot of experience and technical capability relating to uranium enrichment since the 1980s. The Navier-Stokes Equation and other formulaic research projects were found to be in its 5-year state science technology plan in the early 2000s and other projects run by state-run research agencies.

The country in May 2009 revealed its P2 centrifuge during Kim Jong-il's field guidance at a machinery plant in Heechon. A flow-forming machine was later revealed as well. In November 2010, the North showed American scientist Hecker its massive uranium enrichment plant housing 2,000 centrifuges.

This plant consist of two zones and six cascades, with a reported capacity of an annual 8,000kgSWU. The plant enables the North to produce about 40kgs of uranium to build about 2 nuclear weapons.

A Chinese expert with experience in centrifuge production once noted that North Korea can produce probably up to 1,000 to 1,500 P2 centrifuges by now. This means that the country can drastically speed up nuke weapons production when it succeeds in producing weapons-grade highly-enriched uranium.

Existence of a fully-operational uranium plan means that the country probably possesses smaller enrichment tech labs and production plants for large-scale centrifuges. It is possible that other enrichment facilities could exist in other places besides Yongbyon. Uranium enrichment facilities use lower power and can be operated in underground tunnels or sealed buildings and therefore can be difficult detect.

Dr. Albirght of the ISIS, assuming the North had additional enrichment plants in other regions, estimated the North having 90~220 kgs of weapons-grade enriched uranium. This is equivalent to 4~11 nuclear weapons. Some experts argued that the North used some of these for its third atomic test in 2013. The possibility can't be ruled out given the North's persistent venture into nuclear arms.

5) Development of weapons-grade nuclear arms

North Korea reportedly produced weapons grade Pu using a 5MWe reactor. It is also alleged to have developed and tested an implosive-type nuclear weapon. The whereabouts of its success can be deduced from the results of the country's three nuclear weapons. Dr. Kang Jong-min, calculated the detonation force based on the readings from the CTBTO and USGS.[3]

Table 2 Seismic force, explosion power from the North Korea's underground nuclear tests

	CTBTOmagnitude (Mb)	USGDmagnitude (Mb)	CTBTOblast force (kt)	USGSblast force (kt)
1st (2006)	4.0	4.2	0.5	0.8
2nd (2009)	4.5	4.7	1.8	2.8
3rd (2013)	4.9	5.1	4.5	7.3

But there are many errors when applying equal seismic force and interaction formula in every situation. This is because the results vary drastically over the type and state of the terrain. Normally the shockwave tends to be bigger when the rocks surrounding the test are harder. It’s also larger when the rock has a lower porosity from moisture. The size of the earthquake can be reduced drastically by creating a large vacuum hole in the detonation room.

The results in Table 2 are all based on the assumption that the rocks are hard with lots of moisture. The Korea Institute of Geoscience and Mineral Resources assessed the North's third nuclear test as having a power of 6~7 kilotons also under such assumptions. But this is indeed a very conservative estimation.

While the Punggye-ri test site is formed largely of granite, the area may also have large amounts of cracks and soil deposits. It’s moisture levels could also be low, leading to high porosity. A measurement of 10~12 kilotons for the third nuke test would not be far fetched. This would be considered a 'normal' nuclear explosion. The North could be seen as having succeeded in developing weapons-grade nuclear weapons.

The situation may have taken a serious turn if the North used highly-enriched uranium in its third test. Just like China's first atomic test in 1964, if the North uses highly-enriched uranium with an implosive detonative device, the blast force could rise much higher even with a smaller amount of nuclear material. If North Korea uses such a method, the North can drastically boost its nuclear arms stockpile and speed up development of its high-capacity nuclear weapon.

6) Nuclear arms miniaturization

After a successful detonation test, the next step would lead to the development of a miniaturized nuclear warhead. Many experts for the past several years estimated that it would take North Korea several years to develop a miniaturized nuclear warhead. But U.S. and South Korean military officials have suggested the possibility of the North already having developed miniaturized nukes, bringing about conflicting views on the possibility. I personally believe that the country has probably succeeded, based on the five following reasons.

First, the North, in terms of nuclear development, fully took advantage of the so-called latecomer's advantage. Decades have passed since the appearance of the first nuclear weapon. The country took note of the developmental path of its predecessors and was able to acquire data from the Soviet Union and China. Its attempt to miniaturize nuclear arms was preceded by a long nuclear weapons development project. Its Scud missiles are designed by the Soviet Union to load nuclear warheads. It’s natural for country with a small nuclear production capacity to try to miniaturize its nuclear arms and load it onto its ballistic missile.

Second, the North notified China in 2006 after its first nuclear test that its blast force was 4 kilotons. Its nuclear material use was reportedly 2 kg. Most experts than said that it was impossible for the North to make a small high-capacity atomic weapon in such short period. The North, against all doubt, set its goal towards developing a miniaturized nuclear weapon, keeping in mind loading it on its missile stockpile

Third, when Pakistan's Abdul Qadeer Kahn visited North Korea in 1999, he was quoted as having witnessed three nuclear warheads with a 24 inch diameter and 64 detonators in a underground facility some two hours away from Pyongyang. The dimensions are small enough for the weapons to be loaded on missiles. Hwang Jang-yop, the late former North Korean politician who defected to South Korea, also said that the North succeeded in developing small nuclear arms.

Fourth, the country has a history of developing alternative material through the policy of self-reliance. Many experts predicted that the North was incapable of producing cutting-edge material, such as heat-enduring ceramic. But they fail to note that the North's research and development based on the philosophy of self-reliance is quite different from other advanced states abundant with technology and material.

China, two years after its maiden atomic test in 1964, conducted another test using missile warheads made of glass fiber and other self-made material. North Korea may also have taken such route. In an age when technological progress has skyrocketed and international borders becoming more diluted, many alternatives and secondary options exist.

Lastly, the North may have taken full advantage of its horizontal tunnel labs. Normally, nuclear tests are analyzed by measuring the blast force and nuclear material analysis from air sampling. But in underground lab testings, various equipments can be put in place intricately to individually measure implosion effect, neutrons, gamma ray, amount of x-rays. This is referred as a proximity physical measurement.

Testings in sealed underground horizontal labs can produce pure measurements without external interferences. It also allows long-term results from periodical sample readings from test labs. The X-Ray thermo dynamic effects that require vacuous settings can only be measured properly in an underground horizontal laboratory.

North Korea is believed to have acquired sufficient measurements and data to overcome and improve upon its three previous nuclear tests in its underground facility. Other nuclear nations have also moved their overground atomic research into more underground settings in order to conduct proximity physical measurements to push the envelope in nuclear technology.

7) Boosted nuclear arms development

After the third nuclear test, there were suggestions made about North Korea possibly testing a much more advanced nuclear weapon. One of those suggestions was made by the South Korean defense ministry. While examining the research trends of the North's science technology field in the early 2000, I also have raised the possibility of the North developing a reinforced nuclear weapon in the near future.[4]

Included in the second '5-year science and technology development plan' were studies on "D(heavy hydrogen) - T(tritium) nuclear fusion", “Separation of Li^6 from natural Li deposits”. Included in three short-term research studies from 2010 was research on enriching heavy hydrogen from hydrogen sulfide and water.

State of the art equipment, along with nuclear fusion material such as heavy hydrogen, are required to realize D-T nuclear fusion. Given the situation, its most unlikely for the North to have these at its disposal. Handling of tritium is especially difficult, as its form is gas and requiring a reactor for production. It also has a short half life cycle of 12 years.

The North, therefore, will look to China in its way forward, while focusing its energy on its limited resources. One of such efforts may be the development of a reinforced nuclear weapons from a D-T atomic fusion, by amalgamating Li^6 and heavy hydrogen into tritium.

Test of such an advanced atomic weapon can be done in a lab without an actual nuclear explosion. Its possible by making high temperature, high pressure plasma and concentrating it on a single point using reflective mirrors to produce an environment of several thousands degrees in temperature.

North Korea received from China laser nuclear fusion equipment in the 1980s. The North placed this in the facility in Pyongsong and expanded its capacity to boost its test conditions.

The country's scientists in May 2010 announced that they succeeded in nuclear fusion via the Rodong Sinmun. Many skeptics said that without highly-sophisticated equipment, such as a Tokamak, a nuclear fusion would be impossible for North Korea. But they failed to notice that there were many ways to achieve nuclear fusion.

The Chinese press blasted North Korea in harsh rhetoric. This is probably because of the the fact that they knew the North used the China-provided laser nuclear fusion equipment. Further development of nuclear fusion technology would lead to the development of reinforced atomic arms and furthermore hydrogen bomb developments as well.

North Korea's energy crisis and its case for nuclear development

For quite some time, the North has asserted its right to pursue nuclear development for peaceful use. Recently, it has been arguing that its enriched uranium was for use in its self-made light-water reactor. The U.S., under the Geneva Framework Agreement, in fact agreed to provide a light-water reactor in Sinpo, North Korea in return for the North giving up nuclear weapons.

The country is, in fact, in a state of national economic crisis, with the energy problem bearing the brunt. This can be examined in the country's effort to deal with its energy issue by highlighting its nuclear issue. Figure 1 is a basic outline of the country's energy grid. Blue represents hydro plants, red represents thermal and green represents hydrogen plants currently under construction.

Figure 1. North Korea's energy grid layout[5]

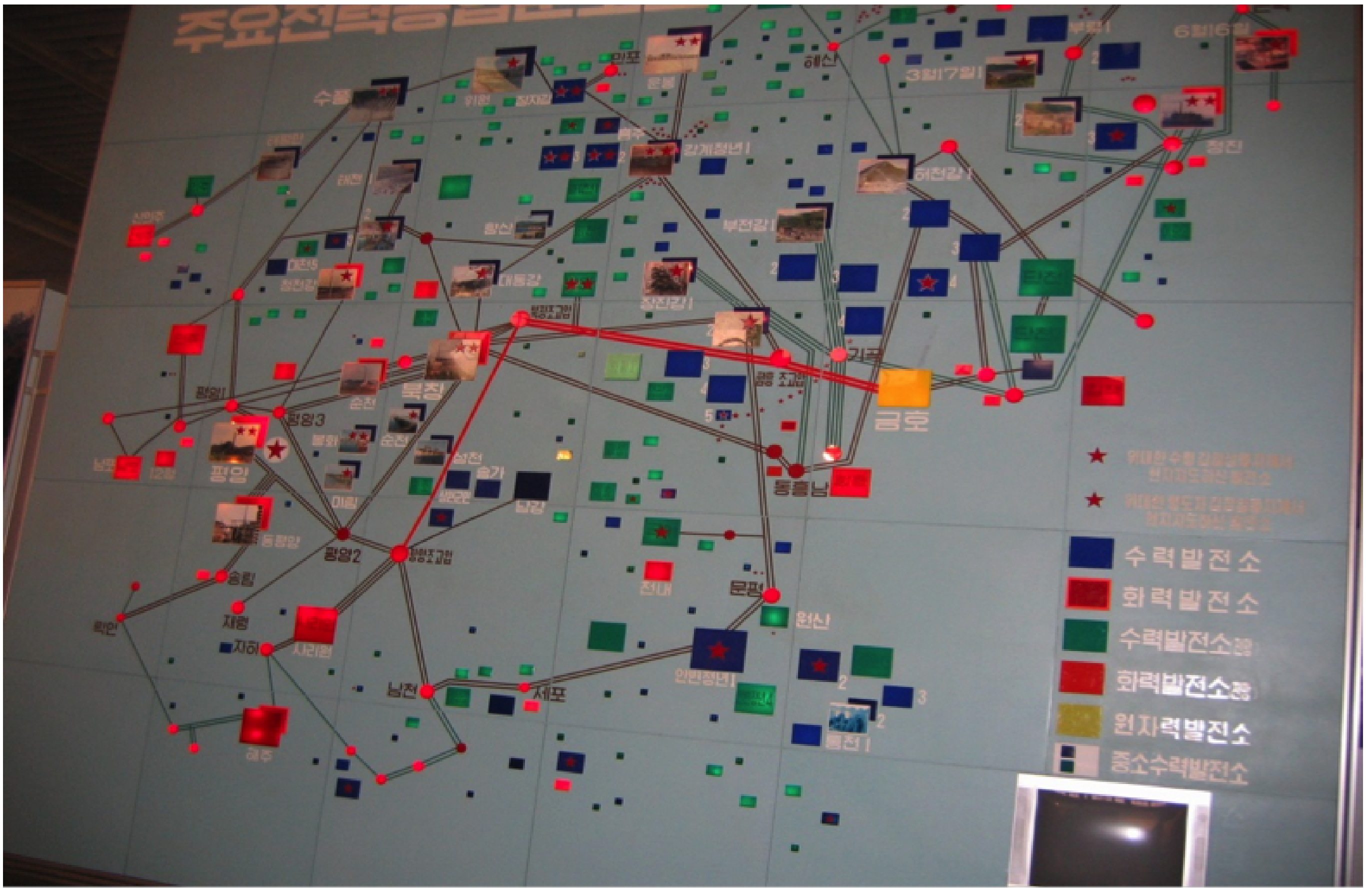

Photo taken at the Pyongyang Three Revolutions of Korean Socialism Museum

The eastern, mountainous regions tend to house a large number of hydro plants, while the industrial, southwestern plain regions have a higher number of thermal plants. The problem with hydro plants, accounting for 40 percent of the country's energy source, is that rainfall drops substantially in winter. The country has established a high-powered electric grid along the boundary dividing the east and west. According to the North's plan, the nuclear power plant in Sinpo, marked yellow, was supposed to provide stable electric power through the line.

But the plan fell through amid the Sinpo reactor construction. The country's thermal energy production also fell steeply after the U.S. suspended provision of heavy oil. The North's backlash was fierce, given the economy was hit hard. It was virtually impossible for the North to sustain its regime relying only on domestic thermal and hydro power without international support.

The overall state of the North's energy problem can be characterized as a lack of natural resources and technical supply. This is why the cost of energy production per unit capacity is two to 10 times higher on average than advanced states and even higher than the international average. This phenomenon was also common among other former socialist countries.

North Korea, therefore, in tackling its energy crisis, is a looking for a rational alternative. The country is making a technical and economic analysis of its overall energy system, energy flow as well as cost balance calculations.

The North is trying to adopt global energy models and create a rational energy supply plan. Points of consideration are 1) minimum cost, 2) energy efficiency 3) stability, 4) safety and 5) cost sharing. The energy supply scenario based such points is shown in Table 3.

Shown is a long-term blueprint consisting of measures to overcome the immediate crisis and further steps towards sustainability. A recovery from the immediate energy crisis would take more than 10 years. This phase focuses on the state's planned energy consumption and strengthening of control and supervision. The country's energy supply demand policy will be under a much stricter leash. It will also probably be more interconnected with the nuclear arms development program.

Table 3. North Korea's energy supply/demand scenario

Classification	Recovery Phase	Activation Phase	Sustainability Phase
Applying principle	Safety,National assurance	Minimum cost, stability,cost sharing	Modernization, stability,efficiency
Energy production	Coal mine development, modernization,plant restoration,nuclear introduction	Production based on demand, dispersed generating,small-sized heavy oil generation	Co-development of foreign resource,super critical coal power,compound circulation generation
Energy supply	Planned supply,limited imports	Energy commercialization,energy service company	Energy trade,energy market service
Energy consumption	Planned consumption,Order-based saving, supervision and control	Consumer-based consumption, policy and saving	Consumer consumption, minimal energy and output standardization

Forecast and implications

North Korea, after decades of effort in its nuclear endeavor, has managed to develop its nuclear program using homegrown resources. Its nuclear industry has grown substantially. It has developed nuclear arms and is strengthening it in size and quality. If the North succeeds in developing weapons-grade enriched uranium and reinforced nuclear arms, we would reach a point where the international community could no longer ignore or tolerate the North's nuclear capacity and capability.

Success of miniaturization and loading of nukes onto missiles would be another flash point issue. Many experts until recently could not conceive the notion of the North successfully loading a small-sized nuclear weapon on its missile. They believed the weight and mass were too large, while the means of firing, accuracy and piercing capability were also insufficient.

In truth, as revealed during the 2010 Yonpyeong shelling, much of the North's weapons have become quite old. Its nuclear weapons program also probably lack parts, resources and technology to support it.

But various signs that have appeared recently allows us to see that the country, based on its philosophy of self-reliance, has in part overcome these obstacles. As our defense capability isn't sufficient to bear such threat, it is imminent for us to reassess the North's overall nuclear capability and draw up countermeasures.

We need to initiate a much deeper study into the North's nuclear-related technology and draw up contingency plans. This should cover not only direct nuclear weapons development but also the country's long-term science and technology blueprint as well. The country's National Science

Institute is deeply involved in military research. Basic and mid-to-long-term studies, to a large part, are conducted by the institute and universities.

Also needed is a technical interpretation, case studies and policy research into the concept of peaceful nuclear use on the Korean peninsula. The two Koreas in the early 1990s agreed to make the peninsula free of uranium enrichment and reprocessing facilities. The South kept this promise but the North did not. We need to review our own nuclear policy as well as examine what meaning the North's argument of for a peaceful use of nuclear power bears.

The North's nuclear capability and infrastructure must be a key factor in preparations for unification as well contingency measures towards a possible North Korean state of emergency. The presidential unification preparatory committee can deliberate on the nuclear cycle assuming a post-unification scenario. The nuclear issue has far more wide-ranging implications than any other matter and requires a much more comprehensive approach in drawing up counter measures.

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