The Overview of the Adaptive Cooperative Threat Reduction Proposal for the Denuclearization of the DPRK

- Non-Governmental Perspectives -

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Summary

The DPRK is unique in that it has voluntarily suggested to work on the denuclearization still disputing the exact meaning of the denuclearization. Since the political regime of the DPRK shall remain stable, the entire denuclearization processes are different from the case after the collapse of the Soviet Union. Even though the denuclearization of the DPRK is a difficult issue, it is the task that the global society as well as the North East Asian one should work together. There are many political, financial, and technical issues at this moment. In this paper, these issues are summarized and certain practical measures such as the energy solution, facility management, and the related infra-structure update are proposed.

1. Introduction

One of the most challenging issues for the denuclearization of the DPRK is how to take care of staff members who are currently involved in the in the Critical WMD Mission (CWMDM) such as the development of Weapon Grade (WG) fissile materials, nuclear weapons, missiles, submarines, and chemical as well as biological weapons. It is essential to propose the comprehensive package to supply the stable and descent job opportunities for the staff members (1) to prevent the proliferation of the critical WMDs (Weapons of Mass Destruction) around the world. Also, since these staff members are the core components of the DPRK's society, to take care of them is the key (2) to stabilize the DPRK society throughout the denuclearization processes. In addition, these staff members are highly educated and well-trained human resources (3) to serve as a backbone for the future economic prosperity of the DPRK society.

Therefore, it is urgent to set up the comprehensive program to develop the new CTR (Cooperative Threat Reduction) tailor-made for the DPRK targeting the human resources management while significantly assisting the future economic development of the DPRK. Since the situation in the DPRK is quite unique, the CTR for the DPRK needs the special name, Adaptive Cooperative Threat Reduction (ACTR) throughout this paper.

To accomplish this mission, we suggest the creation of a small scale non-governmental working group among the ROK, the United States and other concerned states. The ROK has the unique know-how for the DPRK society. And the US has profound accumulated experiences throughout the CTR [1] for the old Soviet Union countries and others in the Middle East. The existing non-governmental entities such as Asia Pacific Leadership Network (APLN) shall be a major player for the creation of an international working group.

The creation of the non-governmental working group can initiate the development of the detailed draft for the action plans on the ***Step by Step*** implementation of the ACTR programs. The draft version is expected to be carefully reviewed by the DPRK so that the final version shall reflect the key comments from the hosting state, the DPRK. During this process, the active participation of the key neighboring states such as the PRC, Japan, the RF as well as the global society such as EU which contributed the creation of the KEDO project and the other global nuclear negotiations is needed. The proposed non-governmental working can be transformed to the international entity later on, if needed, when the all concerned parties such as the DPRK, the ROK, the United States, the other neighboring states and the international bodies finally sign the "Comprehensive Agreement for the Denuclearization (CAD) of the DPRK."

2. Overall Vision of the ACRT

As discussed in the precious Agreed Framework (AF) occasions among key experts, how to properly manage the all different levels of the staff members who are now working in the Critical WMD Mission (CWMDM) is a big challenging issue. To prevent any potential advertent as well as inadvertent proliferation attempt on the nuclear weapon systems and the sensitive ballistic missile technologies, there should be complete effort to limit the access to (1) the very sensitive Special Nuclear Materials (SNMs), (2) a couple of hundred core experts over the bomb and the delivery system development, and (3) the core components to build the critical weapons and the associated delivery systems. This mission is assumed to be accomplished by the strong leadership

of the United States and the other concerned P-5 states in association with the strong cooperation of the DPRK and the responsible international watch-dog IAEA. Thus, the context of that mission shall not be the scope of the tasks of the proposed ACTR, shortly prescribed in this paper.

Still, there shall be more than twenty to thirty thousand staff members [2] who are believed to work in the CWMDM such as acquisition of the SNMs throughout the full operation of the front and the back end nuclear fuel cycle facilities including mining, refining, the yellow cake production, conversion to UF4 and UF6, fuel manufacturing, operation of two critical reactors such as the IRT-2000 and the 5 MWe Magnox type reactors, reprocessing and storage of the Used Nuclear Fuel (UNF), enrichment of the U-235, production of tritium and final separation of it from targets, take-caring of the stockpile of WG SNMs, assembling of nuclear bombs and high explosive components, testing of nuclear bombs and upgrades of the existing designs, and the stewardship of the final products, nuclear bombs.

Also, there are other staff members working on the design of the various sets of missiles in short-, intermediate- and the inter-continental- ranges, production of efficient fuels flight systems, development of critical guiding components, Post Boosting Vehicles (PBVs), re-entry systems and the much lighter carbon fiber development for the air frames and etc along with the independent development of the submarine systems in the DPRK. We do not frankly have the comprehensive information over these huge range networks of the WMD industries in the DPRK. However, based on the current knowledge and the potential future study to identify the capacity of the real DPRK programs, hopefully, we can get good knowledge to take care of all concerned ***staff members*** in these sectors and ***the facilities*** which will be fully managed throughout the full implementation of the CAD.

In practice, the level of knowledge among the staff members in the DPRK's CWMDM shall be very different. Therefore, we should develop the tailor-made approach to find the optimum options for the successful job transfer. The critical components that we shall bear in mind for the design of the ACTR program are:

(1) To fully respect the needs from the hosting state, the DPRK, who has had the strong ambition to achieve the economic quantum jump for the prosperity of the DPRK society throughout the entire denuclearization processes and to implement the sincere and comprehensive take-care systems for their staff members,
(2) To practically ***assist*** the peaceful complete denuclearization of the DPRK, and
(3) To actively contribute the Trust-Building Processes (TBPs) among the concerned parties to further strengthen the CAD system and eventually establish the so-called North East Asia Peace Regime (NEAPR) among the ROK, the PRC, and Japan in association with the United States and the RF in the future.

To accomplish three ambitious goals, we propose the following three specific but strongly inter-connected missions for the ACTR programs;

(1) ***Provision of the Step-by-Step Energy Solution*** to meet the demand from the DPRK through Short-, Mid-, and Long-Term Approaches
(2) ***Development of Comprehensive Work Package to Manage the Key Critical Facilities*** in Yongbyon first, followed by the programs for other cases, and
(3) ***Assisting the Upgrade of the Critical Transportation Infra-structures*** such as railway

systems, road networks, harbors, and key airports to assist the actions on the denuclearization.

Surely, there shall be many other critical components to accelerate the denuclearization in the DPRK such as the cooperative environmental monitoring and etc. But in this paper, we shall try to focus on the most critical issue only, "How to Manage the Staff members in the CWMDM in the DPRK with a strong vision of the Energy Supply."

3. Energy Solution

The energy solution is the one of the major packages which can be act as a practical incentive for the DPRK to join the negotiation table for the CAD. The sustainable supply of energy with the Step by Step approach is essential for the economic development in the DPRK. There are two key areas we have to work on for the development of action plans;

(1) Development of electricity generation systems and
(2) Development of the grid networks to deliver the energy throughout the DPRK.

Throughout this Step-by-Step implementation of the energy solution, it shall contribute substantially to the creation of many descent new job opportunities for the DPRK staff members now in the CWMDM.

We believe that there shall be the following demands from the DPRK for the energy supply.

(1) Strong benefits of the energy solution shall cover the actual DPRK need to solve the current dilemma.
(2) Energy independency for the DPRK not to rely on the foreign natural resources significantly but to accomplish the energy independency as much as possible.
(3) Creation of many descent and stable job opportunities for the staff members now in the CWMDM.

We shall need the careful and profound study to propose optimum solutions satisfying the above requirements throughout the future study. Unlike the previous AF case, it is essential to deliver the package almost immediately to let the DPRK society enjoy the real benefits of the energy solution. This shall act as the critical incentive for the DPRK to sincerely join the table for the negotiation and to initiate TBPs in the immediate future.

- ***Current Status -***

Since the collapse of the old Soviet Union, the DPRK has experienced the energy crisis. Even the operation of the national critical industrial facilities such as Kimchaek Steel Factory has been suffered by the unstable supply of energy and certain critical materials to produce steels. Figure 1 summarizes the energy crisis in the DPRK. Even though the Kim Jong Un Administration has tried hard to introduce the numerous small-scale hydro- and the diesel battery- power stations across the region, the DPRK is still experiencing the significant deficiency of the electricity supply.

Figure 2 illustrates the deployment of newly introduced power stations in Huichon and Taechon areas in the North West region of the DPRK. The total installed national capacity of

the electricity generation is believed to increase by around 2 GWe [3]. Still, the entire installed capacity is still below 10 GWe [3]. If you compare this number to the single unit installed capacity of the Shin-Gori unit 4, 1.4 GWe, the level of the installed capacity in the DPRK is turned out to be very limited. Moreover, the traditionally, the major section of the DPRK industry is the heavy industry which consumes the significant amount of the electricity.

There is the other real issue over the electricity supply in the DPRK. The real annual capacity factor for the actual operation of power plants has been very low after the collapse of the old Soviet Union. Since most of the installed power stations are outdated, the annual capacity factor is believed to be limited to the level of 35 % [3]. If you multiply this capacity factor with the installed power generation capacity, the actual amount of the annual electricity generation turns out to be just around 3 GWe. It literally matches the level of the real annual electricity production from just two units of the APWRs in Shin-Kori Nuclear Complex in the ROK.

Therefore, in order to overcome the current energy dilemma in the DPRK, we shall focus on the two real issues:

(1) How to increase the installed capacity to solve the current dilemma and to meet the potential demand from the future economy development in the DPRK and
(2) How to enhance the annual operational capacity by upgrading the existing facilities with reasonable financial resources.

These are real hard challenges that we are facing with.

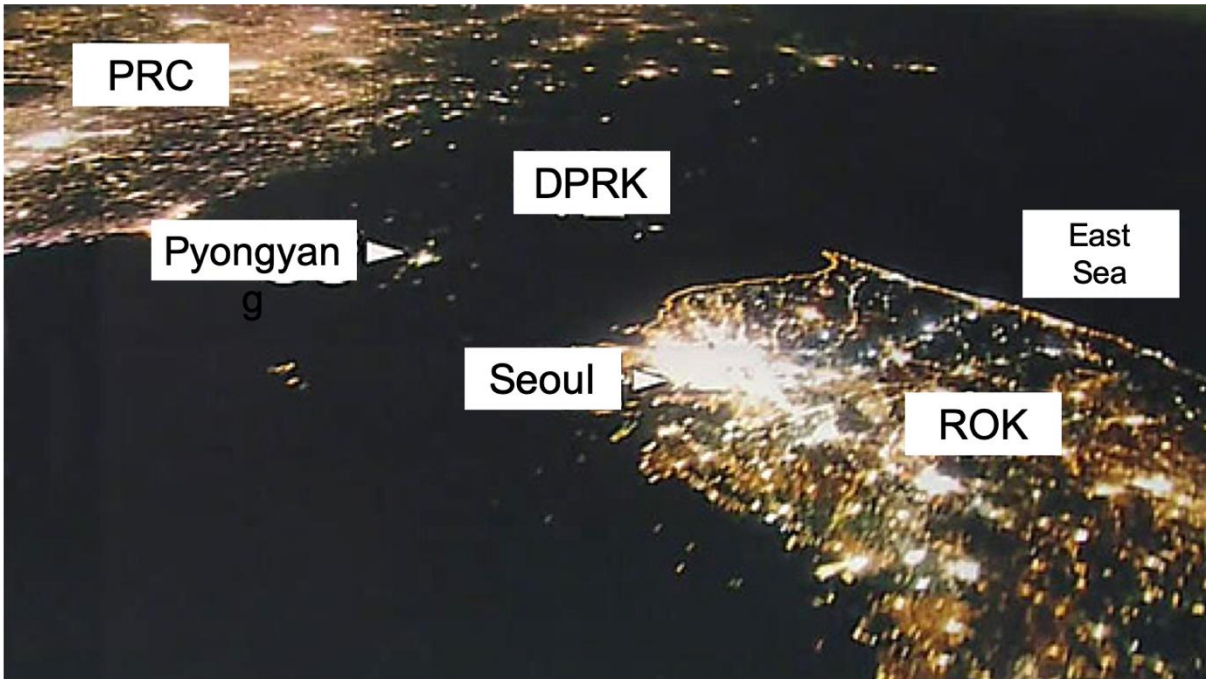

Figure 1. The Current Status of the Energy Supply Issue in the DPRK
[Open Source Information]

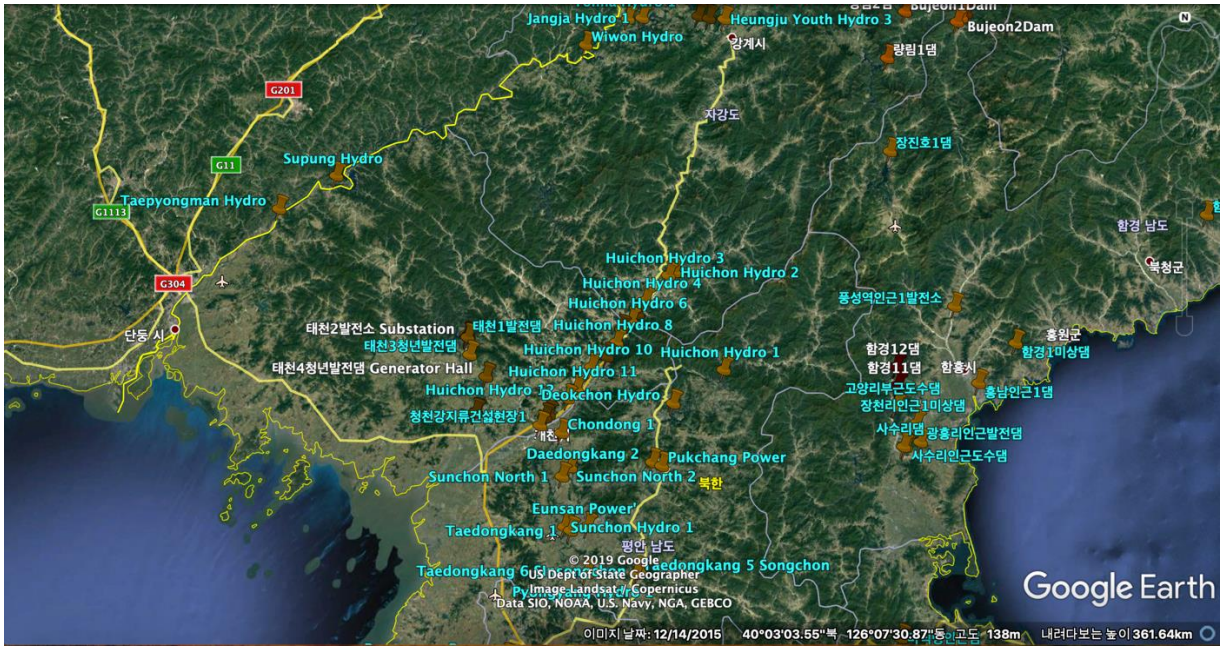

Figure 2. Introduction of Numerous Small-Scale Hydro-Power Stations in Huichon and Taechon Areas Near Yongbyon [Combination of Personal Information with Google Earth Illustration]

- ***Immediate Approach -***

There shall be a lot of practical solutions to promote the short-term effects. Quite recently, many famous high rising buildings were introduced in the Pyongyang area. Due to the strong current international strong economic sanction and the other reasons, many of them are lack of insulation functions such as the weather strips and more against heat waves in summer and the cold winds in winters. The ROK has a full range of knowledge to properly install the needed Components, Systems, and Structures (CSSs) to upgrade the energy efficiency of these buildings and many other traditional facilities in the DPRK. Many practical approaches can be implemented within months or so throughout the strong cooperation between two Koreas.

In addition to the proposal to upgrade the energy efficiency of the buildings, we shall work on the development of a critical approach to supply the electricity and the energy to the remote areas in the DPRK to support the valuable mines [4]. Traditionally, the DPRK is famous for the abundant natural resources such as steel, rare earths, magnesium, and etc. For the successful continuous commercial operation of these mines, many famous mining sites require stable supply of the energy urgently. The stable operation of these mines is the critical component to the DPRK economy to earn the significant amount of hard foreign currency through export and to provide the stable jobs for the local communities. Unfortunately, it shall be impossible to supply the needed electricity through the solid nation-wide grid network immediately.

However, the entirely different approach can be implemented to solve this challenging dilemma throughout the combination of the deployment of small-scale renewable energy generation systems such as wind mills and the so-called micro-grid network systems now in popular in California in the United States. It might be expensive to introduce the combined systems to the DPRK. In addition, it might also require consistent after on-site care to continuously operate the small-scale wind-mills in the remote areas of the DPRK. But certainly,

the introduction of this new system to the DPRK shall deliver the immediate energy solution to support the strong continuous operation of the key valuable mines. If this action plan operates with good success it shall serve as a good example to see the real immediate impact of the energy solution for the DPRK and to further solidify the TBPs.

Certainly, the other energy supply solutions can be added to this new approach. One of the possibilities is to revive the heavy oil supply network with much more strong emphasis on the Assurance of Supply (AoS).

- **Intermediate Approach -**

The effect of the immediate approach shall be great if it is carefully implemented with full support from the ROK and the United States. However, it cannot solve the entire energy dilemma in the DPRK. To solve the real dilemma, we propose the other practical Step-by-Step approaches for the energy solution; intermediate- and ultimate long-term ones.

The first target of the intermediate approach is to carefully review the energy efficiencies of the existing conventional fossil fuel fired power stations in the DPRK [5]. There are many prominent fossil fuel fired power stations in the DPRK such as Pukchang, Pyongyang, and 616 Unggi stations. Some of them were originally designed to use the heavy oil from the old Soviet Union. Unfortunately, after the collapse of the Soviet Union, the operations of these facilities were significantly hampered. The stations like 616 Unggi station has been then converted now, not to use the oil anymore. Instead, It has been converted to use the indigenous coal. Some people may claim that these facilities are outdated. But we fully trust that throughout well-designed renovations, we can significantly enhance the energy efficiencies of these facilities in a timely manner so that these facilities can serve as a backbone for the stable energy supply systems in the DPRK at least for the foreseeable future.

The ROK has developed the mature technologies to fully enhance the energy efficiencies of the conventional coal fired stations. One of the key national laboratories in the ROK to take the lead-role for the immediate approach is KIER in Daejeon, the Korean Mecca for the energy efficiency and the renewable energy solution development. Throughout the active cooperation between two Koreas, the comprehensive upgrades of the old turbine systems and more shall be accomplished within a relative short time period. Also, there is a great open-door joint cooperation opportunity to significantly reduce air pollution from the operation of the coal fired stations in downtowns of big cities such as Pyongyang.

For the time being, these upgraded stations unfortunately, cannot be connected to the nation-wide electricity grid networks. But still, they can serve actively for the local communities throughout the somewhat isolated local grid-network systems. Eventually, throughout the new build of the nation-wide grid networks, these facilities shall be connected to the national electricity systems.

- ***Ultimate Approach -***

Eventually, there shall be the final solution to meet the future strong demand to support the economic development in the DPRK. How to design the ultimate approach requires the significant detailed studies. Through the previous AF, the supply of two units of PWRs from the ROK to Sinpo Complex through the KEDO Project was the sole practical solution. Unfortunately, the KEDO Project was terminated without any tangible outcome even though

the site is well preserved by the DPRK as illustrated in Figure 3. Even after the failure of the KEDO Project, still, all the six party members recognized the importance of the peaceful use of the nuclear energy in the DPRK and decided to support the need as depicted in the September 2005 Beijing Joint Agreement [6].

For the DPRK, the option for the commercial use of the nuclear energy has many prominent advantages. Firstly, the DPRK operates prominent uranium mines such as Pyongsan even though the quantity of the natural uranium in the ores might be not so great. Also, there are some phosphate mines in the DPRK adequate to produce fertilizers. The key by-product of the phosphate ores is uranium at a level of couple of hundreds ppm. Due to the cheap labor cost, these mines in the DPRK has a certain value to provide the domestic uranium resources for the potential peaceful application of the nuclear energy [7]. Of course, there should be a certain security assurance measure to frustrate all feasible activities to assist any clandestine military actions while encouraging the peaceful commercial activities.

The potential revitalization of the nuclear option shall contribute to the creation of the significant amount new job openings in the DPRK. In the ROK, several hundreds of highly trained additional staff members are recruited to operate one new nuclear power station. But in reality, when we shall try to operate one new unit in the nation without any good operation records of NPPs, we shall need more than a thousand experts per each reactor for the safe commercial operation of that reactor.

The other advantage of the nuclear option in the DPRK is that the cost share for the fuel supply is quite significantly low compared with the other energy options. Therefore, once the facilities are successfully installed, then the financial burden to supply the fresh nuclear fuel shall be not so significant at all, compared with other large-scale energy options for the DPRK.

Figure 3. Recent View of the Old Sinpo Site
[Combination of Personal Information with Google Earth Illustration]

- ***Understanding the Importance of Importance of the Indigenous Resources in the DPRK -***

Throughout the history of the energy supply, the DPRK has accumulated the valuable lesson over the importance of the domestic energy resources, especially when the heavy oil supply chain from the old Soviet Union is completely destroyed. In that sense, even though there shall be a certain concern from the Western society over the revitalization of the electricity generation from the nuclear option, the DPRK may still prefer to exercising the nuclear energy supply option to assure the creation of the indigenous electricity supply chain. How to solve this issue is a very delicate matter to be discussed throughout the candid dialogues among all concerned states in the negotiation table. If there is a good political solution to allow the electricity generation through nuclear options with practical solutions fully assuring the nuclear non-proliferation and security without any single break in the future DPRK, then the detailed action plans to materialize the peaceful application of the nuclear energy options while fully discouraging any potential attempt on the EnR (Enrichment and Reprocessing) can be developed for the DPRK.

The active application of the ***fuel leasing and take-back*** shall be the practical cornerstone for the DPRK case. Firstly, the ores extracted from Pyongsan shall be used under the Multi-lateral Nuclear Agreement (MNA). The ROK shall procure the ores from Pyongsan for manufacturing fresh nuclear fuel for the domestic nuclear programs in the ROK to financially support the continuous operation of the mine and to preserve the valuable jobs in that local area [7]. At the same time, certain states such as the RF and the PRC shall also purchase the ores and ship them to their domestic enrichment facilities. The LEU (Lowly Enriched Uranium) from the corresponding enrichment service shall be used to fabricate the fresh fuels in these countries or be sent to the ROK for fuel fabrication service at KEPCO-NF in Daejeon. These fuels then shall send to the DPRK to operate the reactors. Within one year from the discharge from the reactors, the UNFs stored in special transportation casks shall be shipped out to the hosting states for the enrichment services such as the PRC and the RF by existing railway networks [8]. At this moment, there are four railway connections between the DPRK and the PRC and the one between the DPRK and the RF. If the very long-distance transportation is needed, then the combination of the maritime transport in association with the railway service shall also be considered. This fuel leasing and take-back option shall be the solution to practically eliminate the chance of the potential EnR in the DPRK with the complete dismantling of all open and clandestine enrichment facilities in the DPRK and the current radio-chemical laboratory facilities in Yongbyon.

Some might argue that the supply of two units of one GWe PWRs proposed through the KEDO project and the probable new proposal to supply the new systems such as the 1.4 GWe APWRs are too big for the DPRK to match up with the current and the future nation-wide grid network in a timely manner. Also, these days there somebody might claim that the active technology development in the Small and Modular Reactors (SMRs) such as SMARTs developed by KAERI [8] is more adequate for the electricity supply in the DPRK. If the DPRK strongly demands the deployment of the many small-scale power plants across the territory, the implementation of SMARTs shall be a viable option. The full spectrum of the feasible options for the ultimate energy supply solution shall be carefully reviewed in combination with the strong demand to assure the comprehensive nuclear non-proliferation and security measures.

If the DPRK is more interested in other options other than the nuclear one, its request shall be fully respected, of course. Therefore, the future research team's real responsibilities are:

(1) To carefully examine the all spectrum of pros and cons of the feasible options and
(2) To identify the optimum solutions through the active consistent consultations with core states such as the DPRK and the United States.

In addition, the additional comprehensive research is strongly needed to develop the fundamentals on the global cost sharing system development to support the energy solution and the corresponding action plans.

- ***Grid Network System Development -***

There have been many keen suggestions to introduce the so-called the regional energy solution in the North East Asia, recently. For example, Mr. M Son the founder and the CEO of SoftBank in Japan proposed the ambitious combined approach to install the networks of the solar power generation systems in Mongolia in association with the corresponding super-grid networks covering Mongolia, the North Eastern parts of the PRC, two Koreas and Japan. Also, the RF proposed the solid idea on the Pipeline Network for the liquid Gas (PNG) from Siberia to the entire North East region. These projects are good for the construction of the mutual economic ties in the region and the trust-build, when implemented.

However, the real implementation of these ambitious plans will require the significant amount of time and effort so that it cannot serve for the pragmatic silver bullets to solve the current energy dilemma in the DPRK in a timely manner. In reality, the practical solution for the DPRK shall be composed of the well-designed Step-by-Step approach. For this mission, we propose to introduce the combination of the following options:

(1) The so-called Micro-Grid Network for the key remote areas with valuable financial assets [3] and
(2) The Independent Conventional Local-Grid Networks to support the power generation and to distribute the electricity to the nearby regional societies.

Then when the ultimate energy supply approach is done with the fleets of noticeably large-scale stations, the real nation-wide grid network shall be completed in a timely manner.

In practice, the new introduction of the nation-wide grid network shall require the comprehensive detailed action plans and significant financial global investment. But, it is the core task for the eternal energy solution of the DPRK to be fully supported by the regional and the international societies through the denuclearization processes.

4. Decommissioning and Decontamination(D&D) of the Nuclear Installations

- ***Yongbyon First*** –

The proper decommissioning and management of old nuclear facilities in the DPRK and the follow-up activities to manage all kinds of radioactive wastes shall be a real technical and financial challenge. However, it shall serve as good opportunity for creation of descent and sustainable jobs for staff members in CWMDM in the DPRK. The ROK, the United States, and the other neighboring states along with many critical international parties shall assist the comprehensive D&D technology training and the waste management through the D&D processes.

We do not fully understand the entire spectrum of all nuclear facilities in the DPRK. For example, we do not have solid information for the conversion facilities to produce the UF_4 and UF_6. Also, we do not have clear pictures on the full enrichment capacity of the DPRK. In addition, we do not have any knowledge on the stewardship of war heads and stockpiles of the WG materials. The lack of information shall create the uncertainties in our work plans. However, we still shall be able to develop the solid scheme to handle all key facilities by narrowing down uncertainties throughout careful future analyses.

There are more than 300 buildings in Yongbyon for the nuclear activities. Figure 4 illustrates the bird eye view of the Yongbyon Atomic Energy Research Complex (AERC) which began to accommodate many different nuclear installations from 1964 [9]. The AERC firstly introduced the IRT-2000 from the old Soviet Unit. It is now believed to be upgraded to the 8,000 kW level. Each key section of the Yongbyon complex is specialized for specific missions [10] such as

(1) Reactor operation,
(2) Reprocessing, and
(3) Uranium enrichment and tritium separation and etc.

The comprehensive plan to manage the Yongbyon AERC shall require the significant time and the financial resources.

Firstly, three reactors, IRT-2000, 5 MWe Magnox, and the ELWR now still under construction shall require the careful management schemes. The IRT-2000 still uses the 36 % HEU (Highly Enriched Uranium), far exceeding the IAEA limit of the enrichment, 20 %. There is strong demand to immediately shutdown this reactor to stop the use of the HEU in that reactor. However, the IRT reactor has served as a hub to supply radio-isotopes for industrial and medical applications in the DPRK. The DPRK shall need a new route to assure the stable supply of these isotopes. Even though, after 911, the NNSA in the United States has worked hard to develop the non-radioactive substances for the industrial and medical applications, still at least for the moment, it is essential to introduce a new isotope generation reactor with less than 20% enriched nuclear fuels to replace the existing IRT-2000 at Yongbyon AERC. The ROK has accumulated the profound experiences throughout the operation of Hanaro research reactor at KAERI in Daejon, the export of a new research reactor to Jordan, and the current endeavor to construct a new specialized reactor to produce the valuable radio-isotopes for medical and industrial application in the South Eastern part of the country. The proper planning in association with the tailor-made training for the operation of a new reactor such as a new Hanaro reactor shall be done throughout the close cooperation among concerned parties [7].

The well-known purpose of the Magnox reactor in the Yongbyon AERC is simply to produce the WG plutonium throughout the following reprocessing of its 50 tone UNF in the nearby radio-chemistry laboratory. Also, we believe that it has served as a hub to produce tritium to make a booster bomb in the DPRK. The target materials composed of Li-6 shall produce tritium after the proper slowing down of incident neutrons throughout the careful operation of the reactor and additional features. The continuous operation of the 5 MWe Magnox reactor can produce enough tritium to make a booster bomb [11] for a booster bomb test. The DPRK announced that it successfully tested a booster bomb during the 4^{th} test in January 2016 even though there is a certain speculation over the successful explosion of that bomb. But certainly, the results from the

latest test, the 6th test conducted in September 2017 indicated that the DPRK successfully detonated either a booster or a hydrogen bomb. To fully frustrate the production of tritium from the 5 MWe Magnox reactor and possibly from the IRT is critical for the complete denuclearization [11] along with the shutdown of any potential black market connect for the external supply of tritium and deuterium.

The demolition of the 5 MWe reactor inevitably shall produce a by-product, radioactive graphite blocks. It shall require special care to safely dispose of the graphite after the decommissioning to a future deep repository. The actual assistance from the United Kingdom and France which have accumulated the significant lessons to manage the contaminated graphite is highly recommended. In addition, the discharged UNF from the 5 MWe reactor shall require special storage containers [12]. The international team effort is also desirable for the timely delivery of the proper storage casks from the strong contribution from Japan and the United States.

How to take care of the ongoing ELWR Project is the other issue. The comprehensive safety inspection with potential addition of the cooling water supply system shall be needed to assure the safe operation of the new system when the international community decides to support the commercial operation of this new reactor.

Many key buildings in the radio-chemistry laboratory area are relatively familiar to the outside world throughout the previous occasional inspections by the IAEA. Still, certain buildings have been updated requiring the further studies. The real issue for this area is the proper inspection of extracted plutonium, and management of wastes in the Building 500. We believe that this building contains the high-level liquid wastes.

All waste streams shall be carefully inspected to identify the exact amount of the extracted plutonium. Of course, there shall be independent inspection of the 5 MWe reactor with the full records on the reactor operation history and the proper radio-isotope samplings from the graphite blocks inside a reactor. This actual verification process shall be the responsibility of the IAEA, in practice.

Still, the proper management of all waste streams in this building shall be the responsibility of the ACTR missions. How to solidify the complicated liquid wastes into stable vitrified glass forms and any other solid form is a technical challenge because there are many different origins of liquid wastes in this building. It may come from:

(1) The operation of the traditional PUREX reprocessing facilities and
(2) The early time implementation of chemical de-cladding [13].

The United States has accumulated a lot of high-cost valuable lessons in the Hanford site to solidify very troublesome liquid wastes for a long time period. We shall need a special international team for the proper management of the historic wastes in this section. We also believe that there has been a strong possibility to advertently and inadvertently dump some radioactive wastes onto the nearby grounds in this area. In fact, it is not the unique case for the DPRK. Some states made the similar mistakes throughout the early time weapon development. How to remediate the contaminated land requires the proper principle introduction such as the Green Field Approach and the Brown Field one. We need the detailed study to select the optimum option under a certain financial constraint, for the remedial of the concerned areas in Yongbyon.

The accumulated experiences in the United Kingdom and the United States are essential to construct the practical pathway for the pragmatic remedial actions.

All the enrichment related buildings in the Southern part of the Yongbyon AERC are strongly recommended to be completely demolished in a timely manner. Even though some people might claim that the complex is financially valuable asset for the future commercial enrichment service, in reality, it does not make any sense at all. The world leading enrichment facility, ACP located in the United States is based on the 10th generation centrifuge technology. It has experienced the series of difficulty so that the opening of this new facility is indefinitely postponed.

The 8th generation centrifuge facility in the RF is the practically world best facility for the enrichment service. The URENCO enrichment facility in the western Europe based on the 7th generation technology has experienced the difficulty to compete with the Russian one in the global free market. The Yongbyon UEP (Uranium Enrichment Plant) is based on the 2nd generation centrifuge technology [14] supplied by Pakistan so that there is no financial benefit at all to operate the UEP for the commercial service. Also, the operation of the enrichment facilities with centrifuge cascades does not require significant job openings.

Somebody might claim that the UEP shall serve as a new hub to produce some valuable stable nuclides in the future. But how to permanently discourage any potential route for the potential enrichment shall be the top priority for the critical stakeholders in the negotiation table for the CAD so that the entire shutdown of the UEP facilities in the Yongbyon AERC shall be surely pursued.

In addition to the UEP buildings, there are certain facilities in that area to extract the tritium from the irradiated Li-6 targets. The new facilities with five special hot cells shall be decommissioned immediately after the verification.

- ***Other Facilities Outside Yongbyon –***

In the previous section, we discussed the timely management of the facilities in the Yongbyon AERC only. Of course, we shall develop the additional comprehensive plans to manage other known nuclear facilities and the yet unknown clandestine ones. However, we strongly recommend to firstly focus on the development of the action plans over the Yongbyon AERC. As already pointed out in this paper, the Yongbyon AERC accommodates hundreds of buildings covering many key features of the production of WG materials. By implementing the "Step by Step Approach," we shall accumulate the valuable experiences to manage many other sites later on while trying to implement TBPs closely with the DPRK. In addition, we shall acquire more information to fully recognize the real capacity of the DPRK throughout the implementation of the proposed Yongbyon AERC first plan. We shall also develop the entire map for the DPRK facilities not just for the nuclear weapon development but for all other WMD development from the cradle to the grave later on.

- ***Contribution to the Human Resources Management*** –

As illustrated in the previous section, the proper management of facilities in the Yongbyon AERC requires the significant effort among the DPRK and the concerned international stakeholders. The proper management of facilities throughout the transition period followed by the comprehensive D&D implementation along with the proper management of all kinds of radioactive wastes shall serve as a great opportunity to additionally create many new descent job

opportunities for the DPRK staff members now in CWMDM. To open more attractive job opportunities, the international society shall provide the specialized in-depth training programs so that the DPRK staff members shall be fully qualified to serve as a backbone work force for the international joint efforts for the management of concerned facilities in the future.

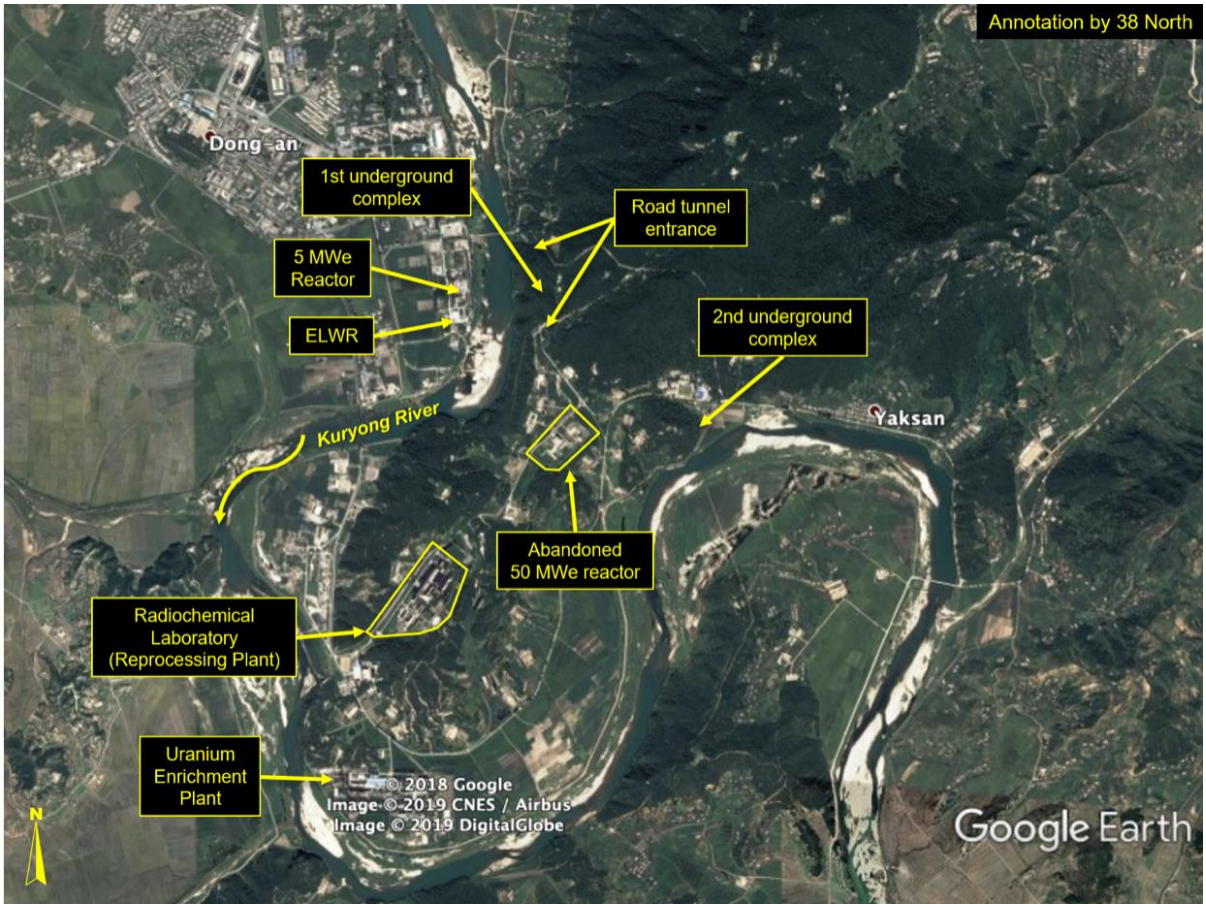

Figure 4. The Bird Eye View of the Yongbyon Atomic Energy Research Complex [AERC] [from 38 North]

5. Upgrade of Transportation Systems

To support the installation of the new energy systems and the upgrade of the existing facilities requires the solid renovation over the transportation network operation in the DPRK. Since the immediate approach in our proposal for the energy supply is targeting at the installation of renewable energy stations in remote locations of the DPRK, assuring the solid transportation routes shall be the key to the successful implementation. Also, we shall need the continuous transportation network operation to manage and dismantle the Yongbyon AERC and the other WMD facilities around the DPRK. It shall require the specific schemes to assist the transportation of heavy non-radioactive and sometimes radioactive materials around the nation.

In practice, we shall develop the comprehensive program to upgrade the corresponding transportation systems in the DPRK. For this mission, even though the potential introduction of the high-speed railway system is a hot issue at this moment in the ROK, we shall focus our

attention to the upgrade of the heavy freight transportation system only in this paper. There shall be a railway transportation, a road transportation, a airway transportation approach, and sometimes the combination of these options to transport the heavy materials to and from Yongbyon, for example.

Critically important SNMs shall be transported from the Yongbyon AERC by special vehicles to nearby Panghyon Airport in Kusong followed by the air transport to the outside world. If needed, two prominent airports Panghyon in Kusong and Kalma in Wonsan shall serve for the practical international air transportation [15]. In reality, many other materials shall be transported by railway and road networks. There is a roadway connect between Kusong and Yongbyong via Taechon. But the railway system in the DPRK is outdated with series of small-scale bridges, tunnels and etc. These bridges and tunnels are typical weak points against heavy freight railway transportation. To rely on the railway transportation, we shall need a systematic upgrade of the conventional railway network nation-wide. Figure 5 illustrates the schematic view of the existing transportation routes around Yongbyon. Even though this map cannot explicitly represent the exact information over the transportation weak points such as bridges and tunnels, the detailed supporting map shows the series of the weak points throughout the system.

If we shall move heavy freights from the western part of the DPRK to Yongbyon, then the practical starting point shall be Wonsan harbor. Starting from Wonsan, there is good railway connection via Kowon, Suncheon, Jeongju, Kusong, to Yongbyon. However, this route passes through the in-land high mountain areas there are series of small-scale tunnels and bridges waiting for the systematic upgrade in the future.

How to upgrade these transportation systems with many noticeable weak points for heavy materials with limited funding resources shall be the challenge for the ACTR program development in the future. It shall require a lot of careful consultation processes and on-site investigations in the DPRK through the active participation of the international experts. The same is true for the road transportation. We can easily recognize the solid highways between

(1) Kaesong and Pyongyang,
(2) Wonsan and Pyongyang, and
(3) the Chongchon-Kang area and Pyongyang [15].

But other road routes are outdated waiting for another systematic upgrades in the future.

The solid upgrade of the nation-wide transportation infra-structures in the DPRK shall require another huge Step-by Step project. When implemented, it shall also create the many new job opportunities for the staff members now in CWMDM.

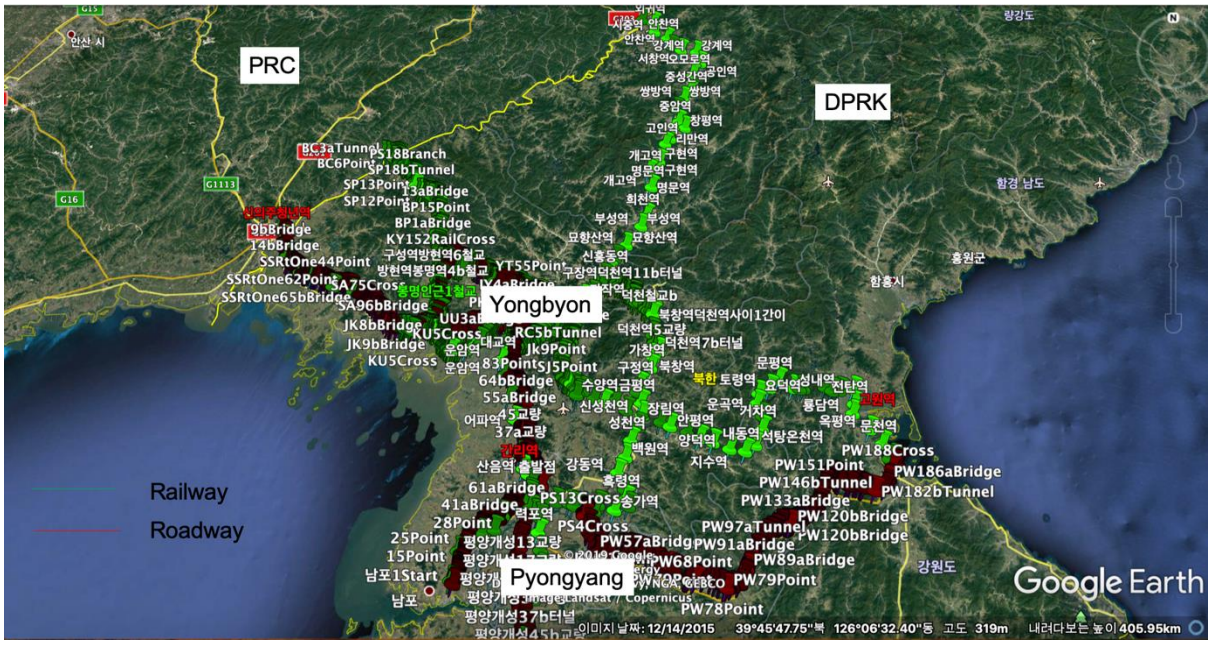

Figure 5. Transportation Networks Around Yongbyon
[Combination of Personal Information with Google Earth Illustration]

6. Conclusions - Rome Was Not Built in a Day -

Even though the importance of the denuclearization in the DPRK has been recognized for many decades, we still need to construct the comprehensive package for the real implementations as early as possible. In this paper, the assembly of new ideas over the so-called ACTR approach is summarized. We strongly propose to develop the international joint team effort especially from the non-governmental entities to collect the key ideas without any political constraints to set up the Draft version of the ACTR action plans. We would like to name it as "***Pre-ACTR Proposal***." Throughout the series of consultations among concerned parties, the main backbone of the ACTR programs shall be developed and then after rigorous review, they shall be recommended to the global and the regional societies for the actual implementation. For this mission, we believe it is important to clearly define the Roles and the Responsibilities (R&Rs) of the ACTR programs right from the beginning. The critical core of our R&Rs shall be

(1) It shall ***not lead but assist*** the successful operation of the international denuclearization efforts ***by proposing the practical solutions to temporary manage and finally decommission the key WMD facilities in the DPRK*** and
(2) It shall systematically ***support the peaceful job transition of many staff members now in CWMDM in the DPRK with different levels of know-how to the long-term descent and stable civilian positions*** while promoting the economic development of the DPRK and supporting the actual denuclearization of the DPRK.

To complete this mission, we firstly, shall try to understand the real capacity of the DPRK WMD business. It shall be a hard task to fully understand the real capacity of the entire DPRK program with limited open source information. Still, we shall do our best to overcome this difficulty and to develop the comprehensive ACTR package in a timely manner.

Development of the ACTR package through the active participation of the global civilian society is very important not only to develop the real action plans but also to create the really solid TBPs among the sensitive stakeholders. As pointed out as the sub-title of this conclusions section, "***Rome was not built in a day***." Our new approach for the ACTR program development shall inevitably face many trials and errors throughout the detailed studies. Still, the transparent approach respecting the real needs from the hosting state of the potential denuclearization, the DPRK and the other concerned parties is the key to success. For this reason, we strongly emphasize the importance of the pragmatic Step-by-Step Energy Solution in this paper. Our effort for the energy supply shall ***produce the immediate benefits as well as the ultimate ones*** in a timely manner. This shall be the real mechanism to build the real trust to consistently support the time-consuming entire denuclearization processes.

In this short paper, we briefly introduce how to manage the Yongbyon AERC. In the near future, we can add the fundamental ideas to manage other nuclear facilities such as the ones for the missile development. Our final comment is to emphasize the importance of the urgent study to develop the fundamentals of the NEAPR. The peace in the North East Asia society cannot be assured in a day. We honestly believe that the denuclearization of the DPRK is a just beginning part to build the regional peace regime. To promote the eternal peace in this region, the comprehensive NEAPR package shall be also discussed in the future.

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Abbreviations

ACTR:	Adaptive Cooperative Threat Reduction
AERC:	Atomic Energy Research Complex
AoS:	Assurance of Supply
APLN:	Asia Pacific Leadership Network
APWR:	Advanced Pressurized Water Reactor
CAD:	Comprehensive Agreement for the Denuclearization
CSSs:	Components, Systems, and Structures
CTR:	Cooperative Threat Reduction
CWMDM:	Critical Weapons of Mass Destruction Mission
DPRK:	Democratic People's Republic of Korea
D&D:	Decommissioning and Decontamination
ELWR:	Experimental Light Water Reactor
EU:	European Union
IAEA:	International Atomic Energy Agency
KAERI:	Korea Atomic Energy Research Institute
KEDO:	Korean Peninsula Energy Development Organization
KEPCO-NF:	Korea Electric Power Corporation - Nuclear Fuel
KIER:	Korea Institute of Energy Research

MNA:	Multi-lateral Nuclear Agreement
MSIT:	Ministry of Science, ICT, and Future Planning
NEAPR:	North East Asia Peace Regime
NNSA:	National Nuclear Security Administration
PRC:	People's Republic of China
Pre-ACTR:	Preliminary ACTR
PUREX:	Plutonium and Uranium Recovery by EXtraction
RF:	Russian Federation
ROK:	Republic of Korea
R&Rs:	Roles and the Responsibilities
SMART:	System Integrated Modular Advanced ReacTor
SNMs:	Special Nuclear Materials
TBP:	Trust-Building Process
UEP:	Uranium Enrichment Plant
UNF:	Used Nuclear Fuel
WG:	Weapon Grade
WMDs:	Weapons of Mass Destruction

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