ENERGY ENGAGEMENT OPTIONS TO SUPPORT A KOREAN PENINSULA DENUCLEARIZATION DEAL

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I. INTRODUCTION

In this essay, the authors outline "an array of possible energy sector assistance projects that might be implemented as part of an overarching agreement with the DPRK to denuclearize the Korean Peninsula. Most of these options have elements that can be implemented in the short-term (for example, capacity-building and humanitarian aid), and medium-term (for example, demonstration projects), and can be implemented in a manner that matches the need for energy assistance calibrated to the denuclearization process that may be set in motion by a US-DPRK summit."

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Banner image: Pyongyang thermal coal fired power plant, Nautilus photo

II. NAPSNET SPECIAL REPORT BY DAVID VON HIPPEL AND PETER HAYES

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Following his early May 2018 visit to the DPRK, Secretary of State Pompeo acknowledged the need to provide the DPRK with energy assistance in return for denuclearization stating that "…private sector Americans coming in to help build out the energy grid – they need enormous amounts of electricity in North Korea; to work with them to develop infrastructure, all the things that the North Korean people need…"[1]

This essay provides a summary description of an array of possible energy sector assistance projects that might be implemented as part of an overarching agreement with the DPRK to denuclearize the Korean Peninsula. Most of these options have elements that can be implemented in the short-term (for example, capacity-building and humanitarian aid), and medium-term (for example, demonstration projects), and can be implemented in a manner that matches the need for energy assistance calibrated to the denuclearization process that may be set in motion by a US-DPRK summit. All these options require a concerted program of assistance over many years.[2] Notably, many are also of keen interest to the DPRK.[3] Most of these cooperation approaches could involve both the United States and other nations, most notably the ROK, and could be configured for deployment by a combination of public- and private-sector actors.

Such energy engagement options in addition should be "robust"—applicable and useful—under a wide range of engagement outcomes (both positive and negative, ranging from smooth and accelerating positive engagement, stop-start, regress, and even military conflict).[4] Energy

assistance should be resistant to military diversion, and should be monitored and verified in course of implementation and energy end-use.

Most important, unlike past energy assistance approaches, both bilateral and multilateral, the primary approaches adopted in future energy assistance should be driven by measures that support the creation of regional energy security that benefits *all* six parties, not just the DPRK. In some instances, for example kick-starting the implementation of a breakthrough denuclearization agreement, exceptions to this rule might be allowable.

For example, it is possible to insulate about 10 percent of Pyongyang's apartments in about six months with an affordable crash program relying on an armada of ships carrying insulation materials to the DPRK and could build confidence, increase access and transparency, and provide potent symbolic evidence of US and allied good faith and intention in a denuclearization deal.[5]

But for the most part, energy assistance should focus on creation of regional energy security that embeds the DPRK in regional energy inter-dependence with the other five parties. As will be evident in following sections of this essay, there is no shortage of immediate, medium-term, and long-term options for energy assistance that meet this standard.

Key DPRK Energy Sector Needs and Cooperation Approaches

The following summarizes key energy sector needs and related potential cooperation approaches.

- **Electricity Transmission and Distribution (T&D) Systems**. The DPRK T&D system is fragmented, antiquated, and in poor repair, and needs substantial refurbishment and/or rebuilding. The most cost-effective approach for international and ROK assistance in this area will be to start by working with DPRK engineers to identify and prioritize a list of T&D sector improvements and investments, and to provide limited funding for pilot installations in a limited area—perhaps in the Tumen River area in counties where key industries for earning foreign exchange (such as mines) are located, or in the Kaesong area.
- **Rehabilitation of Power Plants and Other Coal-Using Infrastructure**: Rehabilitating existing thermal power plants, industrial boilers, and institutional/residential boilers will result in improved efficiency so the coal that is available goes further, will reduce pollutant emissions, and will improve reliability so that the lights and heat stay on longer. Accomplishing these upgrades will require a combination of training, materials (especially control systems), and perhaps assistance to set up and finance manufacturing concerns to mass-produce small boilers and heat-exchange components, particularly, in the short-term, for humanitarian applications, accompanied by a program of "weatherization" of buildings to be heated.
- **Rehabilitation of Coal Supply and Coal Transport Systems:** Strengthening of the coal supply and transport systems must go hand in hand with boiler rehabilitation if the amount of useful energy available in the DPRK is to increase. Foreign coal industries—in the United States and Australia, for instance, as well as China and Russia—have significant expertise to assist with evaluating and upgrading coal mines in the DPRK, including improvements in mining technologies and equipment, in evaluation of coal resources, in mine ventilation systems, and in mine safety. The substantial rehabilitation of the coal sector will not happen quickly, however, and should be accompanied by rehabilitation of the coal transport network.
- **Development of Alternative Sources of Small-scale Energy and Implementation of Energy-efficiency Measures**. North Koreans frequently express a keen interest in renewable energy and energy-efficiency technologies. This interest is completely consistent with both the overall DPRK philosophy of self-sufficiency and the practical necessities of providing power and

energy services to local areas when national-level energy supply systems are unreliable at best. Such projects should be fast, small and cheap. Some of the key areas where the United States and partners could provide assistance are small hydro turbine-generator manufacturing, wind power, solar power, agricultural equipment efficiency measures, building envelope improvement and other measures for improving building energy efficiency, residential lighting improvements, industrial and irrigation motors, and humanitarian measures.

- **Rehabilitation of Rural Infrastructure and Biomass Energy**. The goal of a rural energy rehabilitation program would be to provide the modern energy inputs necessary to allow DPR Korean agriculture to recover a sustainable production level, and for the basic needs of the rural population to be met. A comprehensive rehabilitation program for rural areas would feature a combination of short to medium-term energy supplies from imports and medium to long-term capital construction and rehabilitation projects. Improvements in consumable crop production per unit energy input is a key goal, accomplished by measures that reduce post-harvest losses and early crop consumption, and improve the timing of agricultural activities and inputs.[6] Post-harvest crop losses and early crop consumption alone have been estimated to reduce usable crop production by 20 percent in the DPRK. As a substantial fraction (~ one third) of the DPRK's primary energy supply is wood and charcoal, leading to increased deforestation, there are many possible projects focused on reforestation and biomass fuels that could increase productivity and welfare.

The Simpo Reactor Deal as an Engagement Value Baseline

Completion of one or both of the Simpo light water nuclear reactors was for many years an important issue of national pride to the DPRK, as part of the 1994 US-DPRK Agreed Framework. A recent news story suggested that the DPRK was investigating the completion of these reactors,[7] although the North Korean leadership has to some extent tacitly acknowledged that these reactors may never be completed—hence the DPRK's independent work over the last decade on an experimental small LWR at Yonbyon.[8] Still, the net value to the DPRK of the Simpo light-water reactors (LWRs) remains a marker against which future international energy assistance offers may be judged and may drive North Korean perceptions and demands.[9]

One possible two-LWR-equivalent "package" (albeit out of a practically infinite number of possible combinations of options), could include, over 7 years (probably the minimum to construct a commercial-sized reactor in the DPRK) 1500 MWe (Megawatts of electricity) of hydroelectric plant rehabilitation, 1400 MWe of thermal power and heating plant reconstruction, 210 MWe of local wind power plus pumped-storage hydro, $0.5 billion in energy efficiency investments, 123 MW of diesels for humanitarian applications, and a small LPG terminal. This combination of elements offers the same net value in terms of inputs from abroad to the DPRK—a total of about $1300 million in discounted 2010 dollars—as would two LWR units, but is significantly more valuable in terms of the provision of energy for the DPRK economy.

This benchmark also points to an important aspect of possible energy assistance packages with the DPRK. The DPRK has limited absorptive capacity and until its energy-economic institutions are largely reconstituted with substantial management and workforce training, it is likely that spending more than $1-2 billion a year on energy development projects in the DPRK, even as part of regional energy security strategies, may be wasteful and undesirable.

Regional Cooperation Options in the Energy Sector

Engagement options that require regional cooperation have the potential to engage the DPRK and

its neighbors, as well as U.S. public and private entities, in long-term projects that foster both energy security and international economic co-dependence. Options in the energy sector range from very large infrastructure projects linking many of the countries of the region, to more modest arrangements on technology sharing and capacity-building. Some of these possibilities, in brief, include[10]:

- **Regional oil pipelines**, carrying oil from Siberia, the Russian Far East, and even Central Asia to consumers in Chinas, Japan, and possibly the ROK and DPRK. It is possible that such pipelines could be routed through DPRK territory, providing some oil to DPRK refineries on the way to the major refineries in the southern ROK.
- **Regional natural gas pipelines** have long been of interest to both Russia and the ROK, with China and Japan also seen as possible consumers. Such pipelines would carry gas from The Russian Far East, Siberia, and East Asia to the ROK. Some gas could be used by the DPRK, perhaps initially in a few gas-fired power plants, and later by end-use sectors as DPRK distribution networks develop, with the remainder shipped to the ROK.
- **Electricity grid interconnections**, designed mostly to allow power produced from hydro, coal, and possibly nuclear plants in the Russian Far East to be shipped to the ROK, have been contemplated for well over a decade. The DPRK could obtain "rent" from hosting the line.
- The development of **renewable energy and energy efficiency technologies** have been of keen interest to the DPRK and in many countries of Northeast Asia. Climate change, local and regional environmental concerns, and the desire for economic development all contribute to the attractiveness of these options.
- **Sharing of excess oil refining capacity** to avoid the need to build additional capacity elsewhere in the region.
- **Cooperation on transportation infrastructure** to improve access by all of the nations to markets for their goods and to reduce the time and energy required to deliver raw materials and finished goods to market.
- **Co-development of liquefied Natural Gas (LNG) import capacity by the DPRK and ROK**.
- **Cooperation on regional emergency fuel storage**, including, potentially, agreements on sharing fuel storage facilities, tapping shared storage resources in the event of a supply crisis, and rules for the amount of fuel to be stored (similar to those in force in OECD countries) are all possibilities.[11]

Engagement on Nuclear Energy with the DPRK

North Korea's current and planned use of nuclear technologies may present severe problems with regard to nuclear security and safety. Of most concern is possible loss of control of nuclear materials and/or nuclear weapons due to instability in the DPRK itself associated with a leadership transition or occurring during a conflict. Short of such disorder in the DPRK itself, the DPRK's "routine" nuclear security on fuel cycle sites and its nuclear material- and weapons-related sites is likely to be very stringent. Nonetheless, it may be important to engage the DPRK to ensure that its domestic legislation is fully developed with respect to the obligations that all states must observe with regard to UN Security Council resolution 1540 (passed in 2004). Measures related to 1540 compliance, and training in same, may be useful confidence-building activities in the early stages of engagement of the DPRK to denuclearize its nuclear weapons program.

With regard to nuclear safety, it is understood that the DPRK electric power system in general

operates with very low standards for technical performance and maintenance, in large part due to the DPRK's many decades of isolation from the international community, and also due to the related lack of spare parts and materials, leading to remarkable improvisation but also to a system prone to constant breakdown. Similar practices were observed at Yongbyon nuclear sites during the period of US and IAEA monitoring in the 1990s, and there is little reason to think that this proclivity to take short cuts, conduct speed campaigns, and proceed with regard for worker health and safety that is typically lower than international norms has changed. There is certainly reason to be concerned about the DPRK's construction practices in its construction of the experimental LWR (ELWR) at Yongbyon that has been in process for most of the last decade.

The experimental LWR core could also be disabled accidentally due to poor design, operator error, or hardware failure, but it is too small a thermal mass to lead to a fuel meltdown as occurred at Fukushima, Chernobyl or Three Mile Island. If some other accident or attack disabled the reactor, however, it could release a relatively small amount of radioactive material, but the plume will affect mostly local areas close by Yongbyon.[12]

There are many ways to engage the DPRK with regard to safety and nuclear fuel security, once a realistic framework for denuclearizing the DPRK's weapons program is agreed to and being implemented. Such an engagement could entail some or all of the following steps:[13]

- Helping the DPRK to make or contribute to production of low-enriched uranium (LEU) to convert and fuel the DPRK's IRT research reactor (possible, for example, for use in medical isotope production),[14] and/or, in the future, to supply LEU for small stationary or barge-based LWRs;
- Jointly designing with North Korea a made-in-DPRK small "reunification" reactor based on the ROK's indigenous SMART LWR design that meets international safety and manufacturing standards, possibly in a joint project with ROK LWR manufacturing firms. Such a replacement for the DPRK's own "experimental" small LWR might cost $1 billion to build in the DPRK; and it would need to be matched by a similar commitment to build the requisite supporting stable power grid that would be needed for it to operate safely.[15] Another small reactor option is to design and deploy (or possibly import) a small barge-mounted reactor (possibly Russian) to provide power in a coastal North Korean town, though recent Russian experience suggests that such deployment will take time and may face significant obstacles;
- Undertaking power system planning for the rational development of a national grid capable of supporting a fleet of small LWRs over a decade, likely the bottom-up cumulation of smart and mini grids to support commercially and economically justified power use rather than a grand scheme to build one national grid;
- Creating a multilateral financing scheme (possibly linked to a regional grid connecting the ROK with the Chinese and Russian Far East grids) for the manufacturing and construction of small LWRs in the DPRK over time, starting with a survey of DPRK manufacturing capabilities capable of contributing to or being upgraded to international standards required for safe, reliable LWR production;
- Creating a regional enrichment consortium involving Japan, the ROK and the DPRK (among other possible partners) whereby DPRK enrichment capacities are either incorporated into a safeguarded scheme, possibly operated as part of a multinational facility, in return for which the DPRK would reveal all its enrichment acquisition history;
- Development of a small reactor export program as part of an inter-Korean nuclear export push; and
- Provision of a program of training and institutional development needed to support each of the above activities, which is likely currently almost completely missing in the DPRK today.

- Development of alternative functions and missions—ranging from nuclear safety, nuclear facilities dismantlement and cleanup, and nuclear materials disposal and/or packaging for transfer to the US or its allies, to environmental monitoring and other productive activities—to redeploy and employ scientists and technicians currently working at Yongbyon. Providing such opportunities as a part of cooperative threat reductions can help to minimize opportunities for leakage of nuclear weapons expertise to other nations as DPRK denuclearization proceeds.[16]

CONCLUSION

An engagement on nuclear energy issues including the types of activities described above cannot occur in a vacuum. LWR engagement should be accompanied by engagement on a host of other policy, economic, and humanitarian issues, but most importantly it must be accompanied by engagement on a wide range of other DPRK and regional energy sector issues such as those described above.

III. ENDNOTES

[1] U.S. Department of State (2018), "Interview With Chris Wallace of Fox News Sunday", Interview, Mike Pompeo, Secretary of State, Washington, DC, May 13, 2018, available as https://www.state.gov/secretary/remarks/2018/05/282048.htm.

[2] For a more detailed presentation of how energy sector assistance activities for the DPRK might be phased, see David von Hippel and Peter Hayes (2009), *DPRK Energy Sector Assistance to Accompany Progress in Denuclearization Discussions: Options and Considerations*, prepared for the project "Improving Regional Security and Denuclearizing the Korean Peninsula: U.S. Policy Interests and Options", October, 2009. Available as https://nautilus.org/wp-content/uploads/2012/01/vonHippel.pdf.

[3] This interest was evidenced in Nautilus Institute's interactions with DPRK delegations from 1997 through 2014, but also appears to a large extent in *Intended Nationally Determined Contribution of Democratic People's Republic of Korea*, dated September 2016, and submitted to the United Nations Framework Convention on Climate Change (UNFCCC). This document is available from the UNFCCC website as http://www4.unfccc.int/ndcregistry/PublishedDocuments/Democratic%20People%27s%20Republic%20of%20Korea%20First/DPRK-INDC%20by%202030.pdf.

[4] See, for example, Peter Hayes, David von Hippel, and Roger Cavazos, "Rapid Relief and Reconstruction in a DPRK Humanitarian Energy Crisis", NAPSNet Special Reports, December 23, 2014, available as https://nautilus.org/napsnet/napsnet-special-reports/rapid-relief-and-reconstruction-in-a-dprk-humanitarian-energy-crisis/.

[5] See David von Hippel, Peter Hayes, "Rapid Relief of Humanitarian Stress from Energy Sanctions: Building Energy Efficiency and Solar PV Measures for Rapid Installation in Pyongyang", NAPSNet Policy Forum, April 18, 2018, available as https://nautilus.org/napsnet/napsnet-policy-forum/rapd-relief-of-humanitarian-stress-from-energy-sanctions-building-energy-efficiency-and-solar-pv-measures-for-rapid-installation-in-pyongyang/

[6] Hugh Bentley, "Trends in the DPRK Agricultural Sector & Implications for Energy Use", presentation prepared for the DPRK Energy Experts Working Group Meeting, June 26th and 27th, 2006, Palo Alto, CA, USA). Available as http://nautilus.wpengine.netdna-cdn.com/wp-content/uploads/2012/01/Bentley.ppt.

[7] Yoshihiro Makino (2018), “N. Korea to check abandoned reactors as new power source”, Asahi Shimbun, May 6, 2018, available as http://www.asahi.com/ajw/articles/AJ201805060021.html.

[8] The “ELWR” is apparently not yet operational. See, for example, Frank V. Pabian, Joseph S. Bermudez Jr., and Jack Liu (2018), “North Korea’s Yongbyon Nuclear Research Center: Major Activity at the Five Megawatt Reactor”, *38 North*, April 4, 2018, available as https://www.38north.org/2018/04/yongbyon040418/.

[9] See, for example, David von Hippel and Peter Hayes (2015), "Energy sector cooperation with the DPRK in support of a regional Nuclear Weapons Free Zone", NAPSNet Special Reports, September 21, 2015, https://nautilus.org/napsnet/napsnet-special-reports/energy-sector-cooperation-with-the-dprk-in-support-of-a-regional-nuclear-weapons-free-zone/.

[10] For more comprehensive treatments of these topics, please see David von Hippel and Peter Hayes, “Future Northeast Asian Regional Energy Sector Cooperation Proposals and the DPRK Energy Sector: Opportunities and Constraints”, in *ERINA Report*, Volume 82, July, 2008, available as http://www.erina.or.jp/en/Publications/er/pdf/Er82.pdf; and David von Hippel, Ruslan Gulidov, Victor Kalashnikov, and Peter Hayes, “Northeast Asia Regional Energy Infrastructure Proposals”, Asian Energy Security Special Section of *Energy Policy*, Volume 39, Number 11, November, 2011 Pages 6855–6866, and available as http://dx.doi.org/10.1016/j.enpol.2009.08.011.

[11] See, for example, Eui-soon Shin (2005), “Joint Stockpiling and Emergency Sharing of Oil: Update on the Situations in the ROK and on Arrangements for Regional Cooperation in Northeast Asia”, prepared for the Asian Energy Security Workshop, May 13-16, 2005, Beijing, China, and available as http://www.nautilus.org/aesnet/2005/JUN2205/Shin_Stockpile.ppt.

[12] See David F. von Hippel and Peter Hayes, *Illustrative Assessment of the Risk of Radiological Release from an Accident at the DPRK LWR at Yongbyon*, NAPSNet Special Reports, May 06, 2014, https://nautilus.org/napsnet/napsnet-special-reports/illustrative-assessment-of-the-risk-of-radiological-release-from-an-accident-at-the-dprk-lwr-at-yongbyon-2/.

[13] These and other approaches are outlined in more detail in David von Hippel and Peter Hayes, *Engaging the DPRK Enrichment and Small LWR Program: What Would It Take?*, NAPSNet Special Reports, December 23, 2010, https://nautilus.org/napsnet/napsnet-special-reports/engaging-the-dprk-enrichment-and-small-lwr-program-what-would-it-take/.

[14] See, for example, David Albright and Serena Kelleher Vergantini (2016), *North Korea’s IRT Reactor: Has it Restarted? Is it Safe?*, dated March 9, 2016, available as https://isis-online.org/uploads/isis-reports/documents/IRT_Reactor_March_9_2016_FINAL.pdf; and

[15] See J. Bickel, “Grid Stability and Safety Issues Associated with Nuclear Power Plants”. Prepared for the Workshop on Power Grid Interconnection in Northeast Asia, Beijing, China, May 14-16, 2001 at: https://nautilus.org/wp-content/uploads/2011/12/Bickel.pdf

[16] See, for example, the analyses of the potential re-employment of North Korean nuclear scientists and technicians at US National Academies of Science, Engineering, and Medicine Committee on National Security and Arms Control, “Redirecting North Korean Nuclear Scientists,” 2010, http://sites.nationalacademies.org/pga/cisac/pga_085529.

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