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Energy Insecurity in the DPRK: Linkages to Regional Energy Security and the Nuclear Weapons Issue

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Summary[1]

Energy demand and supply have played a key role in attempts to achieve a settlement of the nuclear issue with the DPRK, and the desire to offset its energy insecurity will be an important concern in any return to negotiations. Recent UN sanctions will aggravate humanitarian pain but have only limited effect on North Korea's nuclear weapons and missile programs. Engaging the DPRK to help to move forward some Northeast Asian regional energy projects that have been under consideration for many years offers opportunities to create regional energy interdependence linking North Korea's economy to that of its neighbours, while also improving DPRK energy security. There is a wide variety of energy sector engagement measures in which North Koreans have expressed keen and consistent interest. A package of such engagement measures, starting small and building as agreements on nuclear weapons security issues are made and implemented, should be a key component of negotiations towards settlement of the DPRK nuclear weapons stalemate and related issues.

Introduction

1. During the 1990s and continuing into the second decade of the 21st century, a number of issues have focused international attention on the Democratic Peoples' Republic of Korea (DPRK). A series of United Nations Security Council (UNSC) resolutions have, in part, targeted the DPRK's energy sector in an attempt to reduce its hard currency earnings and limit supplies of oil products, thereby reducing the resources available for its nuclear and missile programs and, ultimately, bring the DPRK leadership back to the bargaining table – or so the argument goes.

2. Against this larger backdrop, the DPRK's energy insecurity is both a key driver that contributes to and a key element of a negotiated settlement of the DPRK nuclear weapons crisis. For various reasons, the energy sanctions resolutions passed to date are unlikely to have the desired effects.[2] Nonetheless, energy demand

[1] This is a considerably abbreviated version of a paper prepared for the 2017 IFANS Conference on Global Affairs, "Nuclear-Free Korean Peninsula: Strategies and Action Programs for the Moon Jae-in Administration," 11–12 December 2017. The full version, including technical annexes, is available at: https://nautilus.org/?p=47765.

[2] See David von Hippel and Peter Hayes, "DPRK Coal Exports to China under New UN Sanctions: Potential Impacts and 'Work-Arounds'," NAPSNet Special Reports, 14 February 2017, https://nautilus.org/napsnet/napsnet-special-reports/dprk-coal-exports-under-new-un-sanctions-potential-impacts-and-work-arounds/; Peter Hayes and David von Hippel, "Sanctions on North Korean Oil Imports: Impacts and Efficacy," NAPSNet Special Reports, 5 September 2017, https://nautilus.org/napsnet/napsnet-special-reports/sanctions-on-north-korean-oil-imports-impacts-and-efficacy/; and David F. von Hippel and Peter Hayes,

and supply in general – and, arguably, demand for and supply shortages of electricity in particular – have played a key role in many attempts to achieve a negotiated settlement of the nuclear issue with the DPRK. Should the parties to the Korean conflict, in particular the United States and the DPRK, return to negotiations on nuclear and other urgent issues that divide them, it is certain that DPRK energy insecurity will be one of the most important concerns on the table.

3. In any comprehensive future security settlement, energy and economic assistance to the DPRK will ultimately be one of the critical conditions that must be met to convince the DPRK to reduce its level of threat.[3] Carefully designed energy sector assistance projects of modest scale, particularly those that combine economic development and humanitarian focus, should be sought out, designed and, as soon as conditions permit, undertaken. The Republic of Korea (ROK) is in a unique position to develop and deliver such projects and it stands to gain considerably if the projects are successful.

4. For the ROK, engagement with the DPRK on energy issues offers many possible benefits, including:

- an opportunity to improve its relationship with and understand its neighbour;
- a chance to potentially improve the environment that the two nations share;
- an opening for the ROK to invest in and benefit from the development of the North's economy;
- opportunities to potentially link its energy system with potential resource suppliers, most notably the Russian Far East; and
- an opportunity to markedly improve the ROK's security by promoting peace on the Korean Peninsula.

5. It is critically in the interest of the Republic of Korea and its international allies to know as much as possible about the energy resources and needs of the DPRK, so as to be ready, when the opportunities arise, to assist the people of the DPRK in energy and economic redevelopment. The essence of so doing is to provide only that energy assistance that meets international energy development standards for aid; and to insist that the bulk of the assistance be in forms that help to create regional energy interdependence between the DPRK and its "energy neighbours," that is, China, Russia and Mongolia to the north and west, and the ROK and Japan to the south and east.

6. To that end, this paper provides a brief summary of what is known and/or can be inferred about the status of the DPRK energy sector, as well as suggestions as to how the DPRK's energy insecurity might be addressed in ways that could also contribute towards productive engagement with the DPRK on nuclear weapons and related issues.

Overall Energy Situation in the DPRK

7. The overall per capita energy use in the DPRK as of 1990 was relatively high, primarily owing to the inefficient use of fuels and a reliance on coal which is more difficult to use with high efficiency than oil products or gas. Primary commercial energy use in the DPRK in 1990 was approximately 70 gigajoules (GJ) per capita, approximately three times the per capita commercial energy use in China and somewhat over 50 per cent of that in Japan (where the GDP per capita was some ten to twenty times higher than the DPRK) at that time.

8. The dissolution of the Soviet Union, however, deprived the DPRK not only of its main source of energy supplies provided at concessional pricing, but also of its main source of spare

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"Impact of UNSC Resolution 2375 on DPRK Oil Imports," NAPSNet Policy Forum, 12 September 2017, https://nautilus.org/uncategorized/impact-of-unsc-resolution-2375-on-dprk-oil-imports/.

[3] Other essential elements for a comprehensive security settlement include: a Six Party Northeast Asia Security Council, end of sanctions, cessation of state of hostilities, a peace treaty, and a regional nuclear weapons-free-zone. See Morton Halperin, Peter Hayes, Chung-in Moon, Thomas Pickering and Lee Sigal, "Ending the North Korean Nuclear Threat by a Comprehensive Security Settlement In Northeast Asia," NAPSNet Policy Forum, 26 June 2017, https://nautilus.org/napsnet/napsnet-policy-forum/ending-the-north-korean-nuclear-threat-by-a-comprehensive-security-settlement-in-northeast-asia/.

parts for its factories, of markets for its industrial goods and of the technical assistance that was used to build much of its infrastructure. Without this support, the DPRK was forced to rely on its own energy resources and on what energy imports (especially oil) from the international market it could afford to pay in hard currency or barter for other goods. The result was a fairly rapid decline in energy supply and demand in the DPRK through 2000, with energy use by that year less than half, by Nautilus estimates, of what it was in 1990.

9. Significant substitution of "commercial" fuels – oil products, electricity and coal – with wood and other biomass has occurred, contributing to erosion and deforestation and also reducing the efficiency of energy use. Energy using infrastructure itself, particularly in the industrial sector but also in buildings, has become dilapidated and underutilized over time, contributing to the inefficiency of energy use. Energy supply infrastructure, including power plants and, most notably, the transmission and distribution grid, have suffered similar degradation, despite diligent and inventive attempts by DPRK engineers and technicians to keep them operating.

10. Since 2000, some years have seen some improvement in energy supplies, for example in years with good river flow for hydroelectric production, when investment (typically from China) has come in to fund coal mining for export or when new (typically smaller) hydroelectric facilities have come on line. Some other years have experienced declines. Regardless, overall the DPRK had not come close to matching 1990 energy availability by 2017.

11. Facing severe energy security problems and with few goods to sell in international markets, the DPRK ramped up production of the one commodity on which it could reliably trade in the international community: threat, including the threat of instability and even collapse arising from energy deficits and critical shortages with massive humanitarian impacts inside the DPRK itself. Attempts at addressing the DPRK's energy insecurity as a part of agreements to freeze the DPRK's nuclear weapons program have provided some interludes of rapprochement. But 2017 finds the DPRK's nuclear and missile programs as active as they have ever been and its energy sector, despite improvement in some areas and investment in devices like diesel generators and solar photovoltaic panels by businesses and households, still provides North Koreans, on average, with only a small fraction of the energy services that its neighbours enjoy.[4]

12. The key to understanding the current energy insecurity of the DPRK can be found in the following summary:

- Per capita energy use as of 1990 – before the impacts of the collapse of the Soviet Union on the DPRK economy had been felt – was about 70 GJ. By 2010, per capita energy use had fallen to about 26 GJ, indicating a severe restriction in the energy services – such as heated homes, lighting, kilometres travelled and industrial products manufactured – available to the DPRK populace.
- Biomass (including wood) energy use has risen to fill the gap in commercial energy (electricity, oil and coal), albeit only partially and at low efficiency. Heavy biomass use has led to deforestation and soil degradation.
- Coal, of which the DPRK holds billions of tonnes of reserves, remains the dominant form of energy use in the DPRK, but is often used inefficiently.
- Although the DPRK grid nominally has a capacity of 8,000 to 10,000MW (mega-

[4] See, for example, David von Hippel and Peter Hayes, *Foundations of Energy Security for the DPRK: 1990 – 2009 Energy Balances, Engagement Options, and Future Paths For Energy and Economic Development*, 13 September 2012, http://nautilus.org/wp-content/uploads/2012/12/1990-2009-DPRK-ENERGY-BALANCES-ENGAGEMENT-OPTIONS-UPDATED-2012_changes_accepted_dvh_typos_fixed.pdf; David F. von Hippel and Peter Hayes, *Strategies for the Rehabilitation of the DPRK Energy Sector*, NAPSNet Special Reports, 22 June 2014, http://nautilus.org/napsnet/napsnet-special-reports/strategies-for-the-rehabilitation-of-the-dprk-energy-sector/; and David von Hippel and Peter Hayes, "An Updated Summary of Energy Supply and Demand in the Democratic People's Republic of Korea (DPRK)," NAPSNet Special Reports, 15 April 2014, http://nautilus.org/napsnet/napsnet-special-reports/an-updated-summary-of-energy-supply-and-demand-in-the-democratic-peoples-republic-of-korea-dprk/.

watts), the total generation capacity is limited by the poor state of repair of generation, transmission and distribution equipment, as well as by seasonal water flows for hydroelectricity production. Total available generation is therefore in the order of 2000-3000MW, and annual electricity actually consumed by 2014 for a nation of 24 million people was comparable to that used in Washington DC.

- As of 2010, the fraction of total available oil products used by the DPRK military was an estimated 31 per cent, and the military used an estimated 24 per cent of available electricity by 2014.
- The scale of investment required to repair, refurbish and/or replace the elements of the DPRK energy system is considerable. Bringing the electricity grid alone up to modern and fully operable standards will cost tens of billions of dollars. Given the current isolation of the DPRK economy, it will be impossible for North Koreans to achieve this recovery without international assistance. At best, the DPRK can hope to continue to make do with existing infrastructure, augmented with some small hydropower additions and tiny distributed generation systems for individual homes and businesses, resulting in very slow growth in energy availability.

Impact of UNSC Resolutions on the DPRK Energy Sector

13. In the past year, the UNSC has adopted resolutions targeting coal exports from the DPRK and oil imports to the DPRK (S/RES/2321, 30 November 2016 and S/RES/2375, 11 September 2017). The intent of these two resolutions is to reduce the DPRK's access to hard currency earned through sales of coal, historically mainly to China, and to restrict the DPRK's access to oil products used to fuel its military and its nuclear weapons development activities. These resolutions will have largely humanitarian impacts on the DPRK citizenry, but will do little to deter the DPRK from continuing to develop missile technologies or nuclear weapons.[5]

14. The coal import cap included as part of the sanctions described in Resolution 2321 has the potential to decrease the DPRK's coal export earnings by around one billion dollars, which would be about a third of their overall reported exports and thus hard currency earnings. Such a reduction would reduce the DPRK's ability to purchase all types of goods on the international market, but its effect on support for the DPRK's nuclear weapons program would depend on how the DPRK government chooses to allocate the drop in revenue. In practice, however, the effectiveness of the sanctions depends considerably on how China ultimately interprets the sanctions and how stringently it chooses and/or is able to enforce the letter and spirit of the resolution.

15. In addition, as Stephan Haggard notes, the DPRK is "deft" at avoiding and working around sanctions. [6] Actions such as off-the-books trades in coal may cut into the actual reduction in the DPRK's revenues that the sanctions provide, to the extent that the DPRK can adequately finance off-the-books coal production for export. North Korea's production of coal destined for China is largely financed by Chinese companies, which provide the supplies needed to produce the coal. If China implements the export sanctions stringently and the Chinese trading companies involved in coal production in the DPRK likewise comply with sanctions rules, many export mines in the

[5] Hippel and Hayes, "DPRK Coal Exports to China under New UN Sanctions"; Peter Hayes and David von Hippel, "Sanctions on North Korean Oil Imports: Impacts and Efficacy," NAPSNet Special Reports, 5 September 2017, https://nautilus.org/napsnet/napsnet-special-reports/sanctions-on-north-korean-oil-imports-impacts-and-efficacy/; and Hippel and Hayes, "Impact of UNSC Resolution 2375 On DPRK Oil Imports." Related to an earlier UNSC resolution, see also Peter Hayes, David von Hippel and Roger Cavazos, "Sanctioning Kerosene and Jet Fuel in North Korea," NAPSNet Policy Forum, 10 March 2016, https://nautilus.org/napsnet/napsnet-policy-forum/sanctioning-kerosene-and-jet-fuel-in-north-korea/.

[6] Stephan Haggard, "UN Security Council Resolution 2321: A Deeper Dive" (Washington DC: Petersen Institute for International Economics, 5 December 2016), https://piie.com/blogs/north-korea-witness-transformation/un-security-council-resolution-2321-deeper-dive.

DPRK may need to find other sources of critical supplies needed for production.

16. In our estimate, the sanctions included in Resolution 2375 would cut refined product imports to the DPRK by about 60 per cent but would not affect crude oil imports. Additional sanctions just imposed, those included in UNSC Resolution 2397 (S/RES/2397, 22 December 2017), further restrict exports of oil products to the DPRK at 500,000 barrels per year, a significant reduction from recent years. These latest sanctions also cap crude oil exports to the DPRK at 4 million barrels per year, but that level is essentially the same as China's typical exports to the DPRK for most of the last decade and more, so should not change the supplies of domestically refined products in the DPRK.

17. Even factoring in the 22 December 2017 UNSC oil products export restrictions, these levels of reduction are unlikely to have a significant impact on the DPRK's privileged military or nuclear weapons/missile programs. The military sectors will have priority access to refined fuels, including likely fuel from caches of significant volume that have already been stockpiled and provide a substantial buffer against the sanctions. Primarily these sanctions will affect the civilian population whose oil product uses are of lower priority to the DPRK state.

18. The latest UNSC resolution on the DPRK also seeks to strengthen maritime measures to address the DPRK's illicit exports of coal and imports of oil products. In practice, however, the overall sanctions may make more lucrative and thus induce further smuggling of these products, including attracting the interest of smuggling gangs that have operated in the Northeast Asia region for many years.[7] The more that the DPRK invests now in workarounds to oil products restrictions, ranging from curtailment of oil products end-uses and of lower-priority users/geographic areas to fuel switching, producing liquid fuels from coal and smuggling, the more resilient it becomes against any future sanctions-driven cuts.

19. In summary, the UNSC sanctions targeting the DPRK's coal exports, most recently through Resolution 2321, will deprive the DPRK of a source of foreign exchange income, but there are various ways that the DPRK and the nations and traders (principally China and Chinese) that it sells coal to can work around the sanctions to reduce their effect. Coal export sanctions are likely to have a much greater humanitarian impact on individual DPRK workers than on the DPRK's nuclear weapons and missile programs.

The DPRK as a Participant in Regional Energy Infrastructure

20. A resolution of the DPRK nuclear weapons issue would open opportunities for regional cooperation on energy issues that has heretofore been stymied, at least in part, by the difficulties in including the DPRK in regional projects. There remain, however, many different opportunities for developing regional energy infrastructure and for energy cooperation activities – many of which could involve the DPRK – that would potentially benefit a number of regional parties on many levels.

21. For example, as the DPRK economy becomes more integrated with the economies of the region, pipelines and transmission lines could be developed to pass through the DPRK to the ROK, providing service to the DPRK as well. Additional markets for all types of technologies and services would open as the DPRK is redeveloped. Regional cooperation on energy sector initiatives also provides an opportunity to utilize DPRK labour and help to build a sustainable economy in the DPRK. Finally, under international rules for applying Clean Development Mechanisms (CDM),[8] which allow nations to take credit for financing greenhouse gas emissions reduction in other countries, redevelopment in the DPRK may provide a host of opportunities for countries within and out-

[7] See, for example, Chen Aizhu, "China detains gangs accused of smuggling 440,000 tonnes of oil," *Reuters*, 20 April 2015, https://www.reuters.com/article/china-oil-smuggling/china-detains-gangs-accused-of-smuggling-440000-tonnes-of-oil-idUSL4N0XH38320150420.

[8] See United Nations Framework Convention on Climate Change, "What is the CDM?" (UNFCCC, 2017), http://cdm.unfccc.int/about/index.html.

side the region to apply CDM in energy sector investments in the DPRK.

22. Thus engaging the DPRK to help to move forward some of the Northeast Asia regional energy projects that have been under consideration for many years offers opportunities to create regional energy interdependence linking the DPRK's economy to that of its neighbours, while also improving DPRK energy security. Candidate initiatives include international gas and oil pipelines and transmission lines, shared liquefied natural gas (LNG) import facilities and oil refineries, as well as shared projects to improve energy efficiency and deploy renewable energy systems throughout the region.

North Korean Engagement in Regional Nuclear Safety and Security

23. Under conditions whereby the DPRK returns to the denuclearization and nuclear disarmament pathway, it is almost certain that the DPRK will insist on a meaningful element of nuclear power development as part of an overall energy assistance package. Engaging the DPRK on nuclear energy topics related to its two main reactors at Yongbyon and other nuclear infrastructure could range from training and regulatory assistance on nuclear safety, to development of small modular reactors suitable for deployment in the DPRK electricity grid and participation in a regional uranium enrichment consortium.

24. The DPRK will continue to view membership in the "nuclear energy club" as essential for securing its status among nations and, given the history of nuclear power being a part of previous negotiated agreements on the DPRK's nuclear weapons program, in receiving what it has previously been promised. There are various forms of nuclear energy sector engagement with the DPRK, ranging from training in nuclear safety and regulation, to regional cooperation on uranium enrichment and other fuel cycle activities, to joint ventures in development and deployment of small modular reactors. These could comprise elements of an energy assistance package that is part of a comprehensive security settlement of the DPRK nuclear issue, while simultaneously serving to help to bring the DPRK's nuclear facilities under international supervision.

DPRK Energy Sector Engagement Options for the International Community

25. Energy sector technologies and processes for energy sector redevelopment in the DPRK can be identified to address DPRK energy insecurity in a variety of ways. These would be logical elements to offer as inducements to the DPRK for engagement and, in a coordinated, consistent and stepwise fashion, as benefits to offer the DPRK in return for concessions on its nuclear weapons and related programs.[9] The options range from wholesale replacement of the DPRK's electricity transmission and distribution grid, to development of renewable energy systems, deployment of energy efficiency throughout the DPRK economy and rebuilding rural infrastructure to allow the DPRK to feed its people better.

26. Notably, many of these options are also of keen interest to the DPRK, as evidenced to a large extent in the document *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).[10] The DPRK's "INDC" submission provides insights on topics such as the official policies on climate change and other environmental issues, on its intended energy sector (and more broadly, economic) growth through 2030, and its "wish list" of energy sector and other technologies – at least those with potential to reduce greenhouse gas emissions – for which it would propose to seek international assistance in implementation.

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[9] For a more detailed presentation of how energy sector assistance activities for the DPRK might be phased, see David von Hippel and Peter Hayes, *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), http://nautilus.org/wp-content/uploads/2012/01/vonHippel.pdf.

[10] http://www4.unfccc.int/ndcregistry/PublishedDocuments/Democratic%20People%27s%20Republic%20of%20Korea%20First/DPRK-INDC%20by%202030.pdf.

Looking Ahead

27. Helping the DPRK to implement sustainable solutions to its long-term energy problems is a necessary, though not sufficient, condition for enduring success in getting the DPRK to give up or place under international oversight its nuclear weapons, materials and programs, including joining a nuclear-weapon-free zone. Conversely, failing to address the DPRK's underlying needs for energy services now unmet (or poorly met) will virtually guarantee that any solution to the nuclear weapons issue will be unachievable and unsustainable. Sanctions, even if fully implemented by UN member states, will likely make life more difficult for ordinary North Koreans, leaving yet more energy services unmet, but are unlikely to dampen the resolve or significantly reduce the wherewithal of North Korean leadership to pursue its missile and nuclear weapons programs.

28. The options for a sustainable solution to the linked DPRK nuclear weapons and energy insecurity issues are to develop small and large-scale conventional energy supply options, both domestically in the DPRK and regionally networked, to assist with renewables and demand-side management (energy efficiency) options; and to develop nuclear fuel cycle support and possibly joint, safe, small light water reactor options.

29. We do not believe that the light water reactor project under the Korean Peninsula Energy Development Organization (KEDO) itself, or anything resembling it, will be ever resumed and completed. This is so firstly because the United States and its partners are unlikely to agree, but also secondly because the DPRK itself may have decided that the KEDO approach is no longer viable, given the mismatch of such large reactors with its now fragmented and relatively small power grid. Nonetheless, the deal that the DPRK made with the international community in 1994 that included the KEDO reactors remains a benchmark against which the DPRK will inevitably measure other engagement offers. It may, therefore, form a useful precedent and prior agreement on which to "size" an updated energy assistance package as part of a comprehensive security settlement that also resolves the DPRK nuclear issue.

30. Engagement options that involve energy efficiency and renewable energy initiatives are generally robust for application in the DPRK, fulfilling many different considerations with few downsides. One aspect of such options that should not be overlooked, however, is that they will require a good deal of organization and coordination per unit of cost – relative, say, to work on a single major power plant, or provision of tankers of heavy fuel oil. This requirement has many benefits, in terms of capacity building and intercultural interactions, but will need good communications between the groups providing assistance, and between those groups and their DPRK counterparts, to be effectively implemented and administered. Patience and consistency on the part of all parties in developing and implementing these and all cooperation options will also be vital.

31. Larger scale options involving regional energy networks that contribute to regional economic integration, as well as economic integration of the Koreas, may have significant benefits, but will likely be candidates for longer term application. They have the advantage that they are based on projects that are inherently economic from the perspective of regional participants and also provide some benefit to the DPRK. That is, they are not projects that treat the DPRK as a separate energy problem to be solved solely in terms of local energy economics, on which are superimposed geostrategic imperatives related to nuclear weapons by all parties.

32. Generally, smaller, local projects that entail extensive human capacity building will generate more development and more political goodwill than very large, long-term projects. Considering the energy import/export needs and goals of regional players – such as the Russian Far East, China and the ROK – will help planners to understand how best to integrate the DPRK into the regional energy economy while avoiding problems in doing so. This will take careful, site-specific and project-specific joint design, including access to sites and information that the DPRK has hitherto been loath to provide.

33. The DPRK's interest in and current efforts to develop nuclear energy systems cannot be overlooked in developing plans for energy sector engagement. There are approaches to regional nuclear cooperation, starting with capacity building on nuclear safety and related issues, that could, over the next two to three decades – and assuming favourable political conditions – build towards integrating the DPRK with other nations in the region in cooperative nuclear energy projects. These projects would support the goals of a Korean Peninsula Nuclear Weapons Free Zone with regard to transparency of nuclear materials handling and non-proliferation of nuclear weapons materials.

34. To address the inextricably linked issues of the DPRK nuclear weapons and missile programs and its fundamental energy insecurity, it is imperative that the international community develop a set of options for DPRK energy sector assistance that can be offered in return for reciprocal, carefully calibrated and precisely defined commitments on the DPRK side to meet its nuclear disarmament obligations. These options must be designed to be phased in to match the scale, speed and importance of whatever actions the DPRK agrees to take and subsequently verifiably implements, to reduce its threat of nuclear weapons and missile development, deployment and use.

35. The DPRK's obligations likely will come in three phases, with overlap between them. The first is freezing its missile and nuclear testing and possibly its fissile material production. The second would be dismantling its missile and nuclear testing facilities and possibly its missile production and nuclear fuel cycle capabilities, including enrichment. The third phase would be the incremental dismantlement and removal of all nuclear weapons-related hardware and software, and full disclosure of weapons-related activity and capacities, including nuclear-capable personnel. The DPRK's fulfilment of the obligations in each of these phases would also require full monitoring and verification acceptable to and likely implemented by the three NPT-nuclear weapon states that are direct parties in the Korean conflict, and by international agencies such as the International Atomic Energy Agency (IAEA).

36. In phase 1, a package of fast (delivering energy services in 3-6 months from start of work), small and affordable energy assistance using diverse technologies would provide the ability for the five parties, plus other partners such as the European Union (EU), to demonstrate their good faith intention for follow-on assistance to the DPRK. Other steps might entail providing assistance for the DPRK to resume coal exports to China based on provision of clean coal technology and occupational health and safety training and equipment critical to meet the basic human rights of the DPRK workforce working in the coal mines.

37. In the second phase, in addition to expanding the package of small, fast, cheap items implemented at the outset, a set of more valuable, larger-scale but still discrete options might be offered. Examples include provision of a floating power barge, perhaps either using one or more small nuclear reactors (from Russia or the ROK) or a gas-fired unit fuelled with liquefied petroleum gas (LPG), to provide electricity for a coastal DPRK city, such as Nampo or Rason, or another designated economic zone in the DPRK. Such power plants (and fuel for same) could be rapidly delivered and, if the DPRK does not live up to the terms of its freeze agreement, equally rapidly withdrawn, and the energy delivered would be designed so as to avoid any diversion for direct DPRK military use. These are projects that could be brought on-line within a year, and could be implemented fully over a two-three year period that phase 2 is likely to take for completion of facility dismantlement.

38. In phase 3, which may take as much as a decade or even longer to complete, large scale and capital intensive projects might be undertaken. This would include refurbishing the DPRK's hydroelectric dams, its coal-fired generators where economically justified and its existing grid, also where end-uses justify the investment in social and economic terms. The core of the assistance that would be provided in phase 3 would be to create or complete regional energy networks, from Russia, Mongolia and China to the ROK and even Japan, including electric power tie lines, gas pipelines, coal trade, etc. which serve the economic and energy security interests of all the states in the

region, not just that of the DPRK. This would embed the DPRK in networks of regional interdependence that insulate the two Koreas against political manipulation by the other, owing to the interests of the two great powers that would also be integrated into these energy schemes.

39. Energy from these networks can also be provided, where economically justified and technically possible, to the DPRK's own consumers. Energy from international networks, however, is unlikely to be sufficient to support rapid energy development and energy infrastructure needs in the DPRK's domestic energy economy. For that purpose, large scale funding, probably from external partners such as Japan, using intermediaries such as the development assistance and infrastructure development banks, will likely be involved deeply in the DPRK's energy sector with a view to the long term. However, a precondition for this will be an independent determination that its nuclear disarmament is complete and certified to be so by the UNSC and other key parties.

40. As we noted at the outset, the DPRK has spent more than two decades developing its nuclear and missile "deterrent" and will not trade it away cheaply, if at all. There is no question that bargaining to scale back the threat that the DPRK poses will be difficult and slow. As a consequence, the international community must be ready with a set of energy assistance options thought out in advance and varied widely in magnitude, speed of deployment and type, that are ready to offer and implement in a "plug and play" fashion as the process of negotiations with the DPRK demands. In sum, meeting the DPRK's energy security needs will have to form part of the sequencing needed to freeze, dismantle and disarm the hermit kingdom's nuclear weapons program.

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