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# Policy Forum 11-06: Transforming the DPRK through Energy Sector Development



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# Transforming the DPRK through Energy Sector Development

By David von Hippel, Scott Bruce and Peter Hayes

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### I. Introduction

David von Hippel, Nautilus Institute Senior Associate, Scott Bruce, Nautilus Institute Director and Peter Hayes, Professor, RMIT University and Nautilus Institute Executive Director write, “Without convincing the DPRK that it can overcome its energy insecurity and achieve a sustainable energy economy, it is unlikely that Pyongyang will shift away from an economy that emphasizes exports of military hardware and illicit goods, cease its provocative behaviors, and take steps to assume productive relationships with the global community.”

The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Nautilus Institute. Readers should note that Nautilus seeks a diversity of views and opinions on significant topics in order to identify common ground.

### II. Article by David von Hippel, Scott Bruce and Peter Hayes

#### **Transforming the DPRK through Energy Sector Development**

By David von Hippel, Scott Bruce and Peter Hayes

The recent disclosure of the DPRK’s uranium enrichment and Light Water Reactor (LWR) program provides another challenge for the international community, but also a new opportunity for engagement with the DPRK. If the North’s planned nuclear energy program moves forward, engagement is needed to ensure that any LWR program is conducted under international safeguards, and that the DPRK’s enrichment program is secured by international oversight, perhaps as part of a regional nuclear fuel consortium.<sup>[1]</sup> Any engagement of the DPRK on nuclear energy must, however, be accompanied by engagement on non-nuclear energy sector issues as well, since a nuclear energy program alone will not be effective without a redeveloped and modernized energy infrastructure. In particular, immediate engagement on non-nuclear energy will be required since a serious collaboration on LWR and enrichment-related activities will take years to implement.

The DPRK’s energy sector is a key to transforming the North Korean economy into one that is at peace with other nations, is not dependent on weapons exports or illicit activities to earn hard currency, and is self-sustaining. Rehabilitating the DPRK’s energy infrastructure is a necessary albeit insufficient condition for any plausible scenario in which the DPRK gives up its nuclear weapons program. The North cannot develop a modern economy without energy sector assistance, and will not cease its provocative behavior without some agreement that addresses the fundamental state of energy insecurity that prevails in North Korea.

Given the DPRK’s urgent need to modernize its energy economy, regional energy resource sharing projects that might address some of the North’s urgent needs and earn scarce foreign exchange might be of interest to all parties in renewed negotiations. In an October 2010 Nautilus workshop that included North Korean experts, we found, as in previous meetings, that the DPRK delegation was keenly interested in energy engagement opportunities. This interest, which Pyongyang may see as a way to balance the growing influence of the Chinese in the North’s economy has not yet extended to the resumption of active participation in multilateral energy and infrastructure projects such as the UN Greater Tumen Initiative (GTI), though the North apparently remains open to

external and regional energy projects, including bilateral projects involving China and Russia.

There are a number of areas in which international assistance for the redevelopment of the North's energy sector is vital, ranging from "soft" measures such as institution- and market-building, to the rebuilding or replacement of power plants and electricity transmission and distribution networks, to the introduction of renewable energy, energy efficiency, and natural gas technologies that would allow the DPRK to leapfrog intermediate development stages and join regional energy networks. Phased assistance will be needed, starting with confidence-building and substantive capacity-building exchanges, and progressing to longer-term, more extensive projects as the DPRK's capacity to absorb such aid increases.

### **Current Status of the DPRK Energy Sector**

When the Soviet Union was dissolved in 1990, the DPRK lost not only its major supplier of crude oil and of parts for its power plants and factories, but also the markets for the bulk of the goods that its factories produced. The resulting rapid economic and resource contraction was compounded by a series of floods and droughts that affected both agriculture and energy production. Further exacerbated by the economic isolation that resulted from the international reaction to the DPRK's nuclear weapons program, the post-1990 economic contraction resulted in a downward spiral of reduced energy availability and industrial demand as the country's infrastructure fell into disrepair and markets dried up. By 2000, the North's use of coal and production of electricity had fallen to almost a quarter of its 1990 levels, and overall energy end use had dropped to less than 40 percent of what it had been a decade before. Since 2000, the energy sector has been sustained primarily by an annual half-million tonnes of crude oil from China, modest imports of refined oil products, Korean tenacity and ingenuity (which has kept some of its coal mines as well as its aging power and coal production infrastructure running), and the substitution of wood and other biomass for subsistence energy use. Much of the DPRK's major energy and industrial infrastructure dates back decades, with some dating to the 1920s Japanese occupation era.

Since 2000 there have been modest improvements in the energy sector, underwritten, in large part, by Chinese investment. In recent years, the North has announced the construction of new hydroelectric power plants, presumably using domestically-built turbines and generators. Some of these are relatively large (on the order of 50 to 100 Megawatts), but insufficient in output to make much of a dent in unmet demand; the plants probably will mostly serve the areas in which they are located. Another key change has been significant exports of coal from the North to China, in quantities ranging from 2.8 to 3.7 million tonnes per year from 2005 through 2009. Chinese firms have invested in the infrastructure to extract and export coal and other minerals, though the impact of these investments on energy sufficiency in the DPRK itself appears small.[\[2\]](#)

Still, shortages of power and coal persist, with blackouts even in Pyongyang, and much more tenuous power supplies in other areas. Many rural areas, for example, receive power only during key agricultural seasons, and must make do during the rest of the year with alternative fuels. In effect, the North Korean electricity system, although nominally a nationwide transmission and distribution grid, is a patchwork of regional and local grids, centered around major and smaller power plants. The large thermal (almost all coal-fired) power plants are only partially in operation due to damage of various kinds to one or more generating units as well as to transformers, substations, and other parts of the transmission and distribution system. This means that even if large amounts of fuel or electricity were suddenly available to the North, distribution of that energy would be problematic.

Help has been required from other countries for the DPRK's economy to remain even at its current "subsistence" level. As noted above, the North receives sufficient crude oil from China to keep one of

its two oil refineries running, though well below full capacity. This oil is paid for at market prices, but the North runs an annual trade deficit with China. Chinese exports can and do vary by month sometimes substantially (possibly because of political motives, but also due to other factors such as refinery maintenance schedules), but have changed relatively little on an annual basis since 2004. Deliveries in the first few months of 2010 continue this steady pattern. Chinese exports of petroleum products to the DPRK have been similarly stable, averaging about 130,000 tonnes per year since 2003, and varying by a maximum of just over 10 percent on an annual basis during that period. This suggests to us that although China is willing to provide fuel to keep the DPRK economy from failing, it is unwilling to provide sufficient assistance to actually redevelop the North's economy until Pyongyang can afford the additional imports on its own.

The combination of erosion in its energy system and in its industrial and transportation infrastructure as well as the lack of investment capital means that the North will not be able to redevelop its energy system without outside help. Rebuilding power plants—most constructed with major components imported from the Soviet Union and elsewhere—could in most cases, not be done using materials “made from scratch” in the North because the necessary industrial capacity either is no longer operating or was never present. Similarly, decades of relative isolation have left Pyongyang largely without capabilities in metallurgy, electronics, and other fields that would allow it to develop these industries without outside assistance.

### **Energy Sector Assistance for the DPRK: Local, National, and Regional Options**

There is a wide range of options for the international community to provide significant energy assistance to North Korea, from immediate, low-risk, often low-cost steps such as human capacity-building, local pilot projects with humanitarian or economic components, and direct fuels provision, to more substantial national projects such as power system redevelopment, to even more wide-ranging possibilities involving regional cooperation. These options include:

- **Assistance for policy and legal reforms to stimulate and sustain energy sector reconstruction.** Reform of energy pricing practices, development of energy markets, and capacity-building for careful planning that would allow aid to be based on need and rational objectives are all critical areas for assistance. Additional measures could include training for all energy sector actors, strengthening and developing regulatory agencies and educational/research institutions in the DPRK, and involving the international business community in energy sector investments and technology transfer.
- **Rebuilding of the electricity transmission and distribution (T&D) system.** An important first step would be to start working with North Korean engineers to identify and prioritize a list of T&D sector improvements, and to provide limited funding for pilot installations in a defined geographic area—perhaps in a special economic zone or a “demonstration” county.
- **Rehabilitation of power plants and other coal-using infrastructure.** An initial focus should be on improvements in small, medium, and district heating boilers for humanitarian end-uses such as providing heat to residential areas as well as small institutions such as schools and hospitals.
- **Rehabilitation of coal supply and transport systems.** Coal sector rehabilitation will require the building or rebuilding of basic systems in mines for ventilation, light, and motive power for the pumping of water and extraction of coal, as well as improvements in safety. Coal may or may not be the fuel of the future for the North. But it is the fuel of the present, and pursuing economic redevelopment, at least in the short-to-medium term, will require substantially relying on coal.

- **Development of alternative small-scale energy sources and implementation of efficiency measures.** The North Koreans have expressed a keen interest in renewable energy and energy efficiency technologies.<sup>[3]</sup> This interest is consistent with the overall DPRK philosophy of self-sufficiency and the practical necessities of providing power and energy services to local areas when national-level supply systems are unreliable at best. Such projects should be fast, small and cheap, and initially emphasize agricultural and humanitarian applications. They would include the provision of technical and institutional assistance in implementing efficiency measures, and cooperation in technology transfer for renewable energy and efficiency applications. Focusing on efficiency through regional cooperation could provide the North with access to products, materials and parts. Assistance should also include sector-based implementation of efficiency measures and demonstration projects.
- **Rehabilitation of rural infrastructure.** The goal of a rural energy rehabilitation program would be to provide the modern energy inputs necessary to allow North Korean agriculture to achieve a sustainable production level and to meet the basic needs of the rural population.
- **Begin transition to Liquid Petroleum Gas (LPG) networks.** More expensive than natural gas, the infrastructure to import LPG, relative to liquefied natural gas (LNG) is much easier, quicker, and less expensive to develop, and allows imports in smaller quantities. LPG is also clean burning, has limited potential to be diverted for military uses, and such networks can be a first step in any future transition to the use of natural gas. Ultimately, natural gas pipelines and LNG terminals, shared with neighboring countries, can serve as a step toward economic development coupled with regional energy system integration. <sup>[4]</sup>

In addition to these measures, the potential role of regional energy cooperation in addressing the North's needs and helping to build a peaceful economy has long been recognized. Such projects could potentially provide the DPRK with energy (electricity, gas, oil) as well as a source of income from hosting energy facilities. Also, regional connections—whether in the form of infrastructure or in the organizations needed to administer projects—can provide venues for engaging the North. For example, if the DPRK hosts a power line bringing electricity from hydro, coal, or nuclear plants in the Russian Far East to consumers in South Korea, Pyongyang would need to work with both partners in setting technical standards, as well as operations and maintenance protocols. North Korea could also expect annual payments for acting as host. Pyongyang's involvement in other regional cooperation schemes, most prominently including natural gas pipelines from the Russian Far East or Siberia to South Korea, rebuilding and expanding the DPRK's mothballed Russian-built refinery at Sonbong, or collaboration with Seoul on a terminal for importing LNG, would require similar coordination that would arguably be hard for Pyongyang to back away from once it is involved and receiving benefits.

Although the DPRK needs energy to support its populace and meet its development goals, it has thus far failed to fully embrace international efforts that could supply fuel and funding. In the past few years, the North has shown a tendency to pull away from such projects. While Pyongyang has concluded some bilateral deals with China and Russia, it has largely evaded discussions on international energy and other infrastructure collaborations. This may reflect the North's tendency to pull back from external engagement at times of internal stress to limit channels of communication when engaging foreign powers, leaving only select DPRK institutions to move forward in discussions with outsiders. It may also reflect a preference to operate bilaterally in an attempt to reduce coordinated responses by the international community or to avoid placing the South in actual or

perceived positions of power over the North by participating in projects where it would have a measure of control.

Nevertheless, based on our recent workshop with the North Koreans, there seems to be renewed interest in regional energy cooperation. Encouraging Pyongyang's involvement in such projects, even though the benefits of regional energy sharing are unlikely to be reaped until many years down the road, is likely to play an important role in any policy of energy engagement. Based on a desire to keep the United States at arm's length and the fact that many of these strategies rely on Russian-South Korean cooperation, the DPRK may ultimately come to prefer these types of regional engagements to diversify its dependence on external energy suppliers, especially China.

Moreover, it is clear that reliance on China alone to help solve its energy problems will not work. Cooperation with Beijing allows the North Korean energy sector to muddle through, but China's limited assistance is insufficient to resolve the overall energy situation in the North. Chinese energy trade is driven by market forces and influenced by geopolitical considerations. Beijing buys North Korean coal, for example, at prices comparable to imports from other nations, though the range in types imported and the variation in quality from mine to mine make the comparison inexact. Although Chinese electricity imports from the DPRK, representing just a few percent of Beijing's overall electricity imports, are purchased at prices about 40 percent below the average price it pays on the world market, its exports of crude oil and petroleum product to the DPRK are sold at higher prices—about 10 to 15 percent higher in recent years—than Chinese exports to other countries.<sup>[5]</sup> Similarly, China's exports of bituminous coal to the DPRK have been priced higher—about a third in recent years—than its average coal exports. In short, rather than reconstructing the DPRK energy sector or, with the limited exceptions of coke exports (which may be used in making steel exported to China), offering resources at “friendship” prices, Beijing appears to be exploiting its monopolist “sole supplier” position, and, in the case of electricity imports, its “sole buyer” status, to extract modest rents on its energy trade with the DPRK. Moreover, Chinese investment, while substantial, has mostly been in the North's extractive and resource industries and is unlikely to transform the energy sector. As a result, the international community cannot rely on China to rebuild the DPRK energy sector and economy through its investments. Rather, a program of multilateral assistance is necessary to induce the changes that will reduce North Korea's chronic energy insecurity.

### **Limits and Constraints on DPRK Energy Sector Cooperation**

Implementation of energy sector assistance activities requires understanding the constraints of operating in the North. The array of challenges ranges from technical problems with the infrastructure to institutional hurdles related to the structure of the energy sector, to challenges posed by the lack of human capacity. To help enhance the chances of success, the first years of energy assistance should focus on small, fast, cheap, and local energy projects with significant demonstration value.

A sampling of the challenges that assistance activities must address includes:

- Problems with the energy infrastructure, as described briefly above, that could hamper getting assistance programs underway.
- Since there is a suppressed, latent demand for energy services, as infrastructure is rebuilt, the DPRK electricity system and other fuel supply infrastructure will need to accommodate a surge in demand. In addition, measures such as energy efficiency improvements will not appear as effective as anticipated, because a significant portion of the energy saved will be absorbed by previously latent demand.

- Compounding the risk of a surge in the use of energy services is the virtual lack of energy product markets. Without fuel pricing reforms, there will be few incentives for households and other energy users to adopt efficiency measures or otherwise control their fuel consumption. There will also be no guarantee that generators, coal mines, and other fuel suppliers will recover sufficient funds through sales to cover production costs, let alone to reinvest in the further expansion of supply or other upgrades.
- Implementing improvements in the energy sector will require building human capacity. Most North Koreans have a strong general education, but decades of relative isolation have made human capacity scarce in fields such as advanced science and engineering, economics and finance, regulation, and policy development.
- Shortcomings in institutional capacity also pose an important challenge. Because of the North's political structure, only a limited number of officials come into contact with foreigners. These limits constrain the number of projects that the North can be involved in at any given time. The compartmentalization of the North's dealings with foreigners also means that it is often difficult for outsiders to coordinate projects and to work with the appropriate counterparts in the DPRK.

### **Starting Off on the Right Foot**

Given the current state of affairs in the North's energy sector, its recent unwillingness to be a part of regional schemes, and the technical challenges likely to be faced by outsiders seeking to provide Pyongyang with energy assistance, untangling this web of hurdles will be far from easy. There are a number of approaches that can help build confidence and address the needs of the North as well as the United States, its allies and other concerned countries.

A first step would be to work with the DPRK to identify opportunities for the United States and the broader international community to provide humanitarian energy assistance. This could include, for example, providing power and heat (using engine-generator systems fueled with diesel fuel or less diversion-prone liquefied petroleum gas) to hospitals, clinics, orphanages, or schools. Such humanitarian energy supply systems would be provided in tandem with energy efficiency assessments and the application of efficiency measures that would make electricity and heat supplies go further. Humanitarian projects such as these also provide opportunities for interaction between ordinary North Koreans and engineers/technicians from the United States and elsewhere, and serve as a model for badly needed efficiency improvements throughout the North. Although the provision of humanitarian assistance in the energy area is already underway on a very limited basis, including by the Nautilus Institute, an expansion of these operations could have an important humanitarian impact while opening the door for increased government interaction.

Similarly, rapid energy infrastructure improvements that help to provide electricity, heat, or mechanical power for the processing of agricultural products (helping to reduce the fraction of agricultural output lost to spoilage in the fields or post-harvest) will not only be important first steps in confidence-building and engagement, but will have significant value as demonstration projects. In the same way, helping to provide energy infrastructure to support economic ventures that bring in both income through the production and sale, for example, of minerals or of light-industrial, value-added products can demonstrate a way forward for the economy, and again, put North Koreans into working contact with outsiders who are there to help. China is the most active player in the DPRK mineral market but does not have a complete stranglehold. The DPRK has a joint mineral development project with South Korea's Korea Resources Corporation (KORES) in South Hwanghae



province, and has recently agreed to entertain foreign proposals for mineral development on a Build, Own, and Transfer (BOT) basis.

Concurrently, carefully considered energy assistance could be provided as a hedge against instability in the North's economy. Such measures might include the direct provision of fuels, assistance in repairing major electricity infrastructure (ideally coupled with electricity market reforms), and perhaps initial steps toward establishing infrastructure for gas use. While energy trade with China will reduce the risk of the DPRK imploding due to supply shortages, it will not make significant progress on redeveloping the North's energy infrastructure for the long term. Chinese investment in the North's infrastructure typically focuses on the inputs required for specific export-oriented industrial or mining projects, and thus will not result, for example, in the required overall reconstruction of the North's decrepit electricity transmission and distribution system. Assistance that helps induce the DPRK to re-engage in regional energy and economic cooperation projects—such as the Greater Tumen Initiative, gas pipelines, or powerline interconnections—can help to complement the grassroots-level engagement offered by the small projects described above with national-level opportunities.

## Conclusion

North Korea has demanded the inclusion of energy aid and development assistance in every agreement covering its nuclear weapons program because it cannot develop into a “strong and prosperous nation” without such help from the international community. The country's energy infrastructure is decrepit, and until it is redeveloped the country will remain stuck in survival mode. Energy imports from China keep the North afloat while it sells its minerals assets for hard currency. Until the DPRK earns enough foreign exchange to diversify imports and to refurbish its refineries, it has no alternative but to rely on China. This situation means that the United States and its partners must prepare to engage the North on energy issues to prevent conflict, avoid the collapse of the North Korean regime, build transparency and gather real data on the DPRK economy, and develop communication channels with North Korea. Without convincing the DPRK that it can overcome its energy insecurity and achieve a sustainable energy economy, it is unlikely that Pyongyang will shift away from an economy that emphasizes exports of military hardware and illicit goods, cease its provocative behaviors, and take steps to assume productive relationships with the global community.

The DPRK's small LWR and uranium enrichment programs present an additional challenge, but if managed correctly, are an opportunity for engagement on energy issues. Moreover, the immediate demonstration of good faith on both sides will be necessary to proceed with denuclearization. Since big ticket energy infrastructure projects will take some time to deliver, non-nuclear fast fuels and technical assistance will be more useful in the short-term. There are a number of options for energy sector engagement available, ranging from capacity-building in science, technology, law, and economics to assistance with implementation of energy efficiency and renewable energy measures and refurbishing/replacing major energy infrastructure to connecting the DPRK with big regional energy grids. Though engagement should start small, it should also start soon in order to open doors, establish relationships, and create a foundation for the peaceful economic growth in the North necessary to sustain a thaw in the DPRK's relations with the United States, its allies, and the international community.

## III. Citations

[1] For more information on the DPRK small LWR development issue, see David von Hippel and Peter Hayes, *Engaging the DPRK Enrichment and Small LWR Program: What Would It Take?*, NAPSNet Special Report December 23, 2010, <https://nautilus.org/wp->



content/uploads/2012/01/vonHippelHayesLWR.pdf ; and David von Hippel, Scott Bruce and Peter Hayes, Small LWR Development and Denuclearization, 38 North, Washington, DC: U.S.-Korea Institute at SAIS, Johns Hopkins University, February 17, 2011, <http://38north.org/2011/02/small-lwr-development-and-denuclearization/>.

[2] The DPRK did import less than half as much coal from China in 2009 than it did in any of the four previous years, but the quantities of coal imported—in the hundreds of thousands of tonnes—are very modest compared with overall DPRK consumption and exports to China (based on data from China Customs Statistics, as compiled by Nathaniel Aden, 2010).

[3] See, for example, DPRK Delegation (2008), “Introduction of the Building Sector in DPR Korea”. Prepared for the Building Energy Efficiency Technology Training Workshop, Beijing, China, March 8th and 9th, 2008, Available as <https://nautilus.org/projects/dprk-energy/200-meeting/papers/DPRKBuilding.ppt>

[4] For example, as von Hippel, D.F., and P. Hayes (2009b), “DPRK Energy Sector Development Priorities: Options and Preferences,” forthcoming in the Asian Energy Security Special Issue of Energy Policy, and available as <http://dx.doi.org/10.1016/j.enpol.2009.11.068>; von Hippel, D.F., and P. Hayes (2007), Fueling DPRK Energy Futures and Energy Security: 2005 Energy Balance, Engagement Options, and Future Paths (Nautilus Institute Report, available as <https://nautilus.org/fora/security/07042DPRKEnergyBalance.pdf>); von Hippel, D.F., and P. Hayes (2007), “Energy Security for North Korea,” Science, vol. 316, June 1, 2007, pp. 1288-1289; von Hippel, D. F., P. Hayes, J. H. Williams, C. Greacen, M. Sagrillo, and T. Savage (2008), “International energy assistance needs and options for the Democratic People’s Republic of Korea (DPRK),” Energy Policy, vol. 36, issue 2, February 2008, pp. 541-552; and D. von Hippel and P. Hayes, DPRK Energy Sector Assistance to Accompany Progress in Denuclearization Discussions: Options and Considerations, produced as part of the project “Improving Regional Security and Denuclearizing the Korean Peninsula: U.S. Policy Interests and Options,” organized by Joel Wit of Columbia University’s Weatherhead East Asian Institute and the U.S.-Korea Institute at SAIS, Johns Hopkins University, and available as <https://nautilus.org/DPRKPolicy/vonHippel.pdf>.

[5] Study by Nathaniel Aden produced at the 2010 DPRK Energy Exports Working Group meeting in Beijing, September 21-22. Publication forthcoming at [www.nautilus.org](http://www.nautilus.org).

#### IV. Nautilus invites your responses

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