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Security in Northeast Asia

By Peter Hayes and David von Hippel

In coming decades, strong economic growth in Northeast Asia, especially in China, will vastly expand demand for both energy services and fuel.

Projections suggest that future growth of fossil fuel use will not only have major consequences for local and regional financial and fuels markets.

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1 See, for example, P. Clawson, Energy and National Security in the 21st Century (Washington DC: National Defense University Press, 1977)

2 Such as P. Stares, Rethinking Energy Security in East Asia (Washington DC: Brookings Institution with Japan Center for International Exchange, 2000); J. Nye and D. Deese, Energy and Security (Cambridge, Massachusetts: Ballinger, 1981); R.A. Manning, The Asian Energy Factor: Myths and Dilemmas of Energy, Security and the Pacific Future (New York: Palgrave, 2000); K. Calder, Energy and Security In Northeast Asia: Fueling Security (University of California at San Diego: Institute on Global Conflict and Cooperation, 1996)

3 Classics are D. Bohi and M. Toman, "Energy Security and Externalities," Energy Policy 93 (1993): 1093-1109; D. Chapman, Energy Resources and Energy Corporations (Cornell University Press, 1983)

4 D. Bohi and M. Toman, The Economics of Energy Security (Boston: Kluwer Academic, 1996)

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ENERGY-RELATED pollution, which is already undeniable in much of Northeast Asia, will have a profound impact on regional and hemispheric cross-border pollution, as well as global greenhouse gas emissions. How countries in Asia choose to supply their future energy needs will have effects well beyond the region. The sum of these effects will determine the energy security – or insecurity – of every country in the region.

Energy choices also shape geopolitical relations in Northeast Asia, and the rest of the world. Nowhere is this more evident than in North Korea, where the energy security of the nation is a key to peace and stability on the Korean peninsula, and throughout the region.

We believe that by implementing a creative and cooperative framework for energy security in North Korea – and the region as a whole – a dramatic improvement in the environment, human development and military security could result. We start by looking at the concept of energy security.

COMPREHENSIVE CONCEPT OF ENERGY SECURITY

Conventional concepts of energy security begin, and usually end, with a focus on maintaining energy supplies – particularly supplies of oil.[1] Standard academic frameworks for analyzing energy security focus on access to energy resources;[2] on market failures such as oligopolistic pricing and efficiency issues in the delivery of fuels to consumers;[3] and on the affordability of energy supply by weighing the marginal costs and benefits of various measures to increase supply or reduce vulnerability to a loss of supply.[4]

This supply-based bias has as its cornerstone reducing vulnerability to foreign threats or pressure, preventing a supply crisis from occurring, and minimizing the economic and military impact of such a crisis. It matches the supply-oriented engineering cultures of major utilities and energy supply corporations, whether public or private. And it is reflected in the energy policies of most nations.

The fatal flaws in this approach have been exposed in the last decade by major changes in global and national energy systems. As a consequence, a more comprehensive definition of energy security is needed, along with a more workable framework for analyzing the many possible paths to energy security. These changes call, in short, for a radically reformulated concept of energy security, and indeed, new concepts are emerging.

First, given the negative impact on society of climate change and cross-border air pollution, is the idea of globally sustainable energy policies.[5] More recently, new concepts of energy security have arisen in response to large-scale failures of electric utility systems; the threat of terrorist attacks on energy infrastructure; and non-market-based cooperation between states to manage energy uncertainty.

These emerging concepts include three fundamental ideas: energy survivability in the face of a system failure; energy interdependence (between, for example, the energy system and the telecommunications system); and decentralization and diversity of supply (not just geographic, but also in terms of types of fuel, technology and end-users).[6]

REGIONAL COMPREHENSIVE ENERGY SECURITY

Energy, the environment, and security are intimately bound together in Northeast Asia. Choices about energy supply and use, for example, have environmental consequences, and also affect national, regional, and global security. Choices about whether and how to cooperate regionally on environmental issues also spill over into broader energy and security questions.

The issues are interrelated, but unfortunately the policy frameworks and government agencies that implement them are not integrated. Energy planning is conducted primarily by energy ministries with analytical tools that often exclude environmental and security implications. If such concerns are raised, it is usually as an afterthought once energy planning decisions have been made. Issues of regional security, meanwhile, are handled by traditional defense and foreign affairs ministries, whose officials are concerned with external threats. Given the continuing military tensions in Northeast Asia – especially on the Korean peninsula and between Taiwan and China – energy and environmental issues may not be a high priority for security planners. Environmental agencies, in turn, are usually new and weaker organs of government, and are only able to take policy leadership on fairly narrow issues, especially in relation to foreign affairs.

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5 W. Nordhaus, Managing the Global Commons: The Economics of Climate Change (Cambridge, Massachusetts: MIT Press, 1994); D. Streets, "Environmental Aspects of Electricity Grid Interconnection in Northeast Asia," paper to 1st International Workshop on Electricity Grid Connections in Northeast Asia, Beijing, China, May 14-16, 2001, http://www.nautilus.org/archives/energy/grid/papers/streets.pdf. Also published in Energy 28 (2003): 789-807

6 A.Farrell et al, "Energy Infrastructure and Security," Annual Review of Environment and Resources 29 (2004): 421-469; A. Stirling, "On the economics and analysis of diversity," Science Policy Research Unit Working Paper, Brighton, University of Sussex (1998), http://www.sussex.ac.uk/Units/spru/publications/imprint/sewps/sewp28/sewp28.pdf; Stockholm Environment Institute – Boston Center, User Guide for LEAP and TED (2001), http://www.seib.org/leap/webhelp; T. Neff, Improving Energy Security in Pacific Asia: Diversification and Risk Reduction for Fossil and Nuclear Fuels, PARES workshop paper, Tokyo (December 1997), http://www.nautilus.org/archives/papers/energy/NeffPARES.pdf; H. Razavi, Economic, Security and Environmental Aspects of Energy Supply: A Conceptual Framework for Strategic Analysis of Fossil Fuels, PARES workshop paper, Tokyo (December 1997), http://www.nautilus.org/archives/papers/energy/RazaviPARES.pdf; H.C. Shin, J.W. Park, H.S. Kim and E.S. Shin,"Environmental and economic assessment of landfill gas electricity generation in Korea using LEAP model," Energy Policy 33, Issue 10 (July 2005): 1261-1270; and S.H. Lesbirel, "Diversification and Energy Security Risks, The Japanese Case," Japanese Journal of Political Science vol 5, no 1 (2004): 1-22

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7 See A Framework for Energy Security Analysis and Application to a Case Study of Japan, Nautilus Institute, http://www.nautilus.org/archives/pares/PARES_Synthesis_Report.PDF

An important step in promoting regional cooperation as part of a wider framework of multilateralism in Northeast Asia is for policy makers to articulate common concepts and strategic goals. A framework that simultaneously addresses all three prongs of the energy-environment-security nexus is needed. A new, integrated concept of *regional comprehensive security* may provide such a framework.

The end of superpower confrontation in the early 1990s triggered a complete rethinking of traditional concepts of national, regional, and global security. Superpower rivalries focused on the protection of national sovereignty, and external military threats. The new reality emphasizes three additional dimensions:

- The inclusion of a broader range of external threats and potential sources of international conflict, including environmental degradation and resource scarcity, including energy;
- A focus on threats to *human* security, that is, to individuals and communities, within as well as between nations, including food shortages, disturbances to ecosystems, human rights abuses, and ethnic, religious and gender discrimination;
- A focus on regional and global cooperation as an essential way to enhance national security.

The environmental, energy and human security frameworks provide a common basis for collaborative regional initiatives in Northeast Asia. A commitment by all states to promote ecologically sound and secure energy development is critical to enhancing security and sustainability.

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Before governments can make such a commitment in the form of joint initiatives, however, a consensus must emerge among leading thinkers and opinion-makers.

MULTIPLE ATTRIBUTES OF ENERGY SECURITY

In research collaboration with colleagues in East Asia,[7] the Nautilus Institute has developed an operational approach to analyzing energy security in the way described above. This approach, which uses multiple attributes, relies on analysis of energy security in a number of dimensions, tracked qualitatively and quantitatively at each level. Five key components – environment, technology, economics, social and cultural factors, and post-Cold War international relations (especially military and security) – are added to the traditional supply-side concept to

Table 1

Dimensions and Attributes of Energy Security

Dimension of Energy Security	Attributes	Interpretation
Energy Supply	**Total Primary Energy**	**Higher** indicator of other impacts
	Fraction of Primary Energy as Imports	**Lower** preferred
	Diversification Index by fuel type, primary energy	**Lower index value** preferred
	Diversification Index by supplier, key fuel types	**Lower index value** preferred
	Stocks as a fraction of imports key fuels	**Higher** greater resilience to supply interruption
Economic	**Total Energy System Internal Costs**	**Lower** preferred
	Total Fuel Costs	**Lower** preferred
	Import Fuel Costs	**Lower** preferred
	Economic Impact of Fuel Price Increase as fraction of GNP	**Lower** preferred
Technological	**Diversification Indices for key industries** such as power generation by technology type	**Lower** preferred
	Diversity of R&D Spending	**Qualitative** Higher preferred
	Reliance on Proven Technologies	**Qualitative** Higher preferred
	Technological Adaptability	**Qualitative** Higher preferred
Environmental	**GHG emissions** tonnes CO_2, CH_4	**Lower** preferred
	Acid gas emissions tonnes SO_x, NO_x	**Lower** preferred
	Local Air Pollutants tonnes particulates, hydrocarbons, others?	**Lower** preferred
	Other air and water pollutants including marine oil pollution	**Lower** preferred
	Solid Wastes tonnes bottom ash, fly ash, scrubber sludge	**Lower** preferred (or at best neutral, with safe re-use)
	Nuclear waste tonnes or Curies, by type	**Lower** preferred, but qualitative component for waste isolation scheme
	Ecosystem and Aesthetic Impacts	**Largely Qualitative** Lower preferred
	Exposure to Environmental Risk	**Qualitative** Lower preferred
Social/Cultural	**Exposure to Risk of Social or Cultural Conflict over energy systems**	**Qualitative** Lower preferred
Military/Security	**Exposure to Military/Security Risks**	**Qualitative** Lower preferred
	Relative level of spending on energy-related security arrangements	**Lower** preferred

Dimension of Energy Security
Energy Supply
Economic
Technological
Environmental
Social/Cultural
Military/Security

Table 2

Energy security comparison: BAU versus alternative paths

Attributes	BAU path result	Alternative path result
Total Primary Energy	**2010: 26.2 EJ*; 2020: 28.7 EJ**	**2010: 22.0 EJ; 2020: 28.7 PJ**
Fraction of Primary Energy as Imports	**2020: 96% of fuel use**	**2020: 85% of fuel use**
Diversification Index by fuel type, primary energy	**2010: 0.254** **2020: 0.240**	**2010: 0.262; 2020: 0.230, 0.213 and 0.175** with separate accounting for pipeline gas, energy efficiency
Diversification Index by supplier, key fuel types		**Not quantified,** but probably lower
Stocks as a fraction of imports key fuels	**Oil: 150 days stocks in 1995 lasts for 110 days in 2020**	**Oil** 150 days stocks in 1995 lasts for 187 days in 2020
Total Energy System Internal Costs		**27 Trillion Yen** (net present value) less than BAU path over 1990 to 2020
Total Fuel Costs		**32 Trillion Yen** (net present value) less than BAU path over 1990 to 2020
Import Fuel Costs		**About the same** as total fuel costs
Economic Impact of Fuel Price Increase as fraction of GNP	**In 2015,** energy resource costs about 1% of GDP more than in Alternative path	**Impact of 2010 oil price rise to 4,725 Yen per bbl** about 27 trillion Yen NPV less than BAU path, 1990 to 2020.
Diversification Indices for key industries such as power generation by technology type	**For electricity generation:** **2010: 0.166** **2020: 0.138**	**For electricity generation:** **2010: 0.153** **2020: 0.105**
Diversity of R&D Spending		**Probably Higher**
Reliance on Proven Technologies	**Higher**	
Technological Adaptability		**Probably Higher**
GHG emissions tonnes CO2, CH4	**In 2020: 1,600 Mte CO2, 300 kte CH4, 120 kte N2O**	**In 2020: 1,000 Mte CO2, 310 kte CH4, 82 kte N2O**
Acid gas emissions tonnes SOx, NOx	**In 2020: 2.0 Mte SOx, 5.2 Mte NOx**	**In 2020: 1.1 Mte SOx, 3.2 Mte NOx**
Local Air Pollutants tonnes particulates, hydrocarbons, others?	**In 2020: 3.8 Mte CO, 1.1 Mte Hydrocarbons, 0.94 Mte Particulates**	**In 2020: 2.8 Mte CO, 0.55 Mte Hydrocarbons, 0.54 Mte Particulates**
Other air and water pollutants including marine oil pollution		**Somewhat lower to substantially lower,** depending on pollutant and pollutant source
Solid Wastes tonnes bottom ash, fly ash, scrubber sludge		**Likely somewhat lower** (depends on fuel sulfur, ash contents, degree of scrubbing)
Nuclear waste tonnes or Curies, by type		**Somewhat** (~5-10 percent over 1990 to 2020) lower; on-site spent fuel isolation means less waste transport
Ecosystem and Aesthetic Impacts	**More large-infrastructure-related impacts**	**More indigenous-energy related aesthetic impacts;** less ecosystem impacts due to pollutants
Exposure to Environmental Risk		**Lower**
Exposure to Risk of Social or Cultural Conflict over energy systems		**Likely lower overall,** but may require more social and cultural adjustment
Exposure to Military/Security Risks		**Likely** somewhat lower
Relative level of spending on energy-related security arrangements		**Likely** somewhat lower

* One Exajoule, or EJ, is equal to one billion gigajoules, or 10 18 Joules.

Source: A Framework for Energy Security Analysis and Application to a Case Study of Japan, available from Nautilus Institute as http://www.nautilus.org/archives/pares/PARES_Synthesis_Report.PDF

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generate a working definition of comprehensive energy security:

"A nation-state is energy secure to the degree that fuel and energy services are available to ensure: a) survival of the nation, b) protection of national welfare, and c) minimization of risks associated with supply and use of fuel and energy services. The national energy policy dimensions of energy security within each of these three objectives of energy security must be measured by and address energy supply-related economic, technological, environmental, social, and cultural, and military/security-related dimensions. Energy policies must address the domestic and international (regional and global) implications of each of these dimensions. Thus, national energy policies should be evaluated against each of the three basic objectives as manifested in the domestic and international implications of each dimension. What distinguishes [this] definition is its emphasis on the imperative to consider extra-territorial implications of the provision of energy and energy services while recognizing the complexity of actualizing (and measuring) national energy security." (Hayes and Von Hippel, 1996)

This definition is noteworthy, because it considers ramifications beyond national borders. Some of the possible measures of this broader concept of energy security, and the dimensions and attributes that need to be tracked in order to determine the trend in national energy security as defined in this way, are summarized in Table 1 (previous page).

Typically, energy security has been considered solely from a national or local perspective. For this reason, rigorous use of this broader definition of energy security would generate opportunities for cooperation, and warnings about potential conflict. Applied regionally, this definition would help highlight over-reliance on nuclear reactors in a particular power sector, or under-emphasis on international factors, such as exposure to upwind acid rain.

This conceptual framework also considers the impact of environmental factors on human and military security, the effects of security institutions on the environment, and the effects of environmental security ideas on prospects for international environmental cooperation. The environmental implications are three-fold: a) protection of the health and welfare of citizens from the effects of environmental change; b) protection of national economic interests from the negative consequences of environmental change; and c) securing unstable regions against adverse environmental change that may impact on a nation.

This approach allows us to track and weigh diverse quantifiable and non-quantifiable costs and benefits of energy security measures. Table 2 (previous page) shows the summary results from systematic application of this framework to Japan. The table compares two energy paths,

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8 For details, see D. von Hippel and P. Hayes, "Northeast Asian Regional Energy Infrastructure Proposals And The Dprk Energy Sector: Opportunities And Constraints," Korean Energy Economics Institute's Northeast Asia Energy Focus (May 9, 2005)

one, business-as-usual (BAU), and the other, a path that emphasizes energy efficiency, increased natural gas usage, and securing reliable fossil fuels while keeping constant the fraction of power generation from nuclear reactors.

COOPERATIVE ENERGY SECURITY

Northeast Asia suffers from a wide range of energy insecurities, ranging from standard concerns over loss of oil, gas, and coal supplies due to market factors to the risk of nuclear accidents or terrorist attacks on energy infrastructure. Considerable attention is now devoted to local air pollution, the accelerating levels of acid rain and other pollutants transported from China to the two Koreas and Japan, and trans-hemispheric spread of chemically potent dust particles by storm systems from inner Eurasia and China across the Pacific to North America and beyond.

Below we examine the potential for four types of regional cooperation that could improve energy security in ways that national go-it-alone policies nested in global energy markets cannot. (There are many other examples for potential cooperation that could be addressed – for example, the potential for emergency fuel-sharing under a regional energy charter, or the use of mechanisms under the Kyoto Protocol to reduce China's expanding production of acid rain and greenhouse gases.)

We will confine our analysis, however, to the creation of regional energy networks for gas and power trading; the disposition of spent nuclear fuel; promotion of renewable energy and end-use efficiency technologies; and improving North Korea's energy security. These examples of cooperative strategies serve to demonstrate our conclusions about the most productive means of realizing regional energy security.

REGIONAL INFRASTRUCTURE PROPOSALS

The countries of Northeast Asia already constitute the world's largest market for liquefied natural gas (LNG), and one of the world's largest markets for crude oil and petroleum products. Recent economic growth, particularly in greater China and the Republic of Korea, has significantly increased both energy demand and imports, with an attendant increase in related environmental problems. The combination of this growth and its current and future environmental consequences, coupled with the availability of lightly-used energy resources in the Russian Far East and other areas of the former Soviet Union, have resulted in a number of proposals for regional energy and transport infrastructure. The discussion below focuses on regional electricity grid proposals, which we consider to be the most viable near-term option, but also touches on proposals for gas pipelines, and for road and rail infrastructure development.[8]

ELECTRICITY GRID INTERCONNECTIONS

There are a number of proposals for interconnecting the electricity grids of South Korea, North Korea, China and even Japan with the Russian Far East. These are typically designed to move electricity generated at hydroelectric,

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9 See, for example, S. Podkovalnikov, Study For "Russian Far East–Korea, People's Democratic Republic–Republic of Korea" Power Grid Connection: Analysis of Current Status, the Second Workshop on Regional Power Grid Interconnection in Northeast Asia (May 6-8, 2002), http://www.nautilus.org/archives/energy/grid/2002Workshop/Podkovalnikov_020617.PDF

10 For example, see papers by Felix Wu, Lev Koshcheev, and J.K. Park, the First Workshop on Power Grid Interconnection in Northeast Asia (May, 2001), http://www.nautilus.org/archives/energy/grid/papers.html

11 For example, see papers by Karsten Neuhoff and Ivar Wangensteen, the First Workshop on Power Grid Interconnection in Northeast Asia (May, 2001), http://www.nautilus.org/archives/energy/grid/papers.html

12 See David F. Von Hippel, "Estimated Costs and Benefits of Power Grid Interconnections in Northeast Asia," the First Workshop on Power Grid Interconnection in Northeast Asia (May, 2001), http://www.nautilus.org/archives/energy/grid/papers.html

nuclear, or natural gas-fired facilities in Russia to consumers in China and/or Korea. The driving forces behind these proposals are the intense demand for electricity in South Korea, China, and Japan, together with low electricity use and large resource endowment in the sparsely populated Russian Far East. There are, however, major technical and political barriers to regional grid interconnection – namely, North Korea's fragmented electricity grid.[9]

Options considered to date for grid interconnection include elaborate proposals for transmission lines involving Japan, including one for a transmission "ring" surrounding what is commonly called the Sea of Japan. In addition, there are proposals for segments of transmission lines linking one or more Chinese regional grids to the Russian Far East or other parts of eastern Russia. Cost is a key consideration. It is estimated that a line linking the Russian Far East to North and South Korea could have capital costs between US$500 million and US$1 billion, though costs might be even higher due to the need for AC-DC-AC converter stations to deal with the different frequencies used by these national grids.[10]

For this kind of trade in electricity to be commercially viable, there must be a sufficient and complimentary seasonal availability of surplus generating capacity in the connected countries. For example, the Russian Far East has available excess capacity in the summer, but little in the winter. The situation in South Korea is the reverse. The ability to distribute excess capacity in one country to another country where generation is needed would allow one or more countries to avoid building new power plants to meet peak and/or baseload power needs. The higher these "avoided capacity costs" are, the more economical the transmission link will be.

To be sure, the arrangements needed to establish a multi-lateral institution to operate a Northeast Asia transmission link are not trivial, nor are the arrangements that would be needed to agree on power pricing and the rents for power transmission facilities crossing national territories. Some international examples for such arrangements exist, but none operate in a political climate similar to that of Northeast Asia.[11]

Nevertheless, initial analyses of the economic potential of interconnecting the power grid of the Russian Far East to that of South Korea, going through North Korea and possibly parts of China, indicate it may be cost-effective to do so on purely economic grounds, or may even be a cost-effective way to reduce overall regional greenhouse gas and other air pollution emissions.[12] More detailed feasibility studies, and modeling of the power systems to be interconnected, are needed to better characterize the net benefits or costs of the different interconnection schemes.

GAS AND OIL PIPELINE PROPOSALS

In the area of oil and gas pipelines, there are more than 20 proposals for exporting gas from Eastern Russia and/or the countries of Central Asia to China, Korea, and Japan. These range from relatively short pipelines linking Sakha-

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13 Mark J. Valencia and James P. Dorian, "Multilateral Cooperation in Northeast Asia's Energy Sector: Possibilities and Problems," University of California Institute on Global Conflict and Cooperation, Policy Paper 36 (1996)

14 The US Department of Energy's Energy Information Administration, in its International Energy Outlook 2002, estimates the cost of China's proposed domestic 4,300 kilometer gas pipeline development at US$4.8 billion. The pipeline will have a throughput of 12 to 20 billion cubic meters annually.

15 A near-term US$1.7 billion pipeline development linking oil fields in Eastern and Western Siberia with Daqing in China is described in Julia Nanay, "Developments in Projects to Export Oil and Gas from Russia to Asia," Middle East Economic Survey No 45 (November 2002)

Table 3

Estimates of production of spent fuel, and plutonium in spent fuel in Northeast Asia: 1990 to 2020

	Spent fuel (tonnes heavy metal)			
	1990 to 1999	2000 to 2009	2010 to 2020	1990 to 2020
Base case	12,084	17,714	21,377	51,175
Max. nuclear	12,374	19,698	40,013	72,085
	Plutonium (tonnes)			
	1990 to 1999	2000 to 2009	2010 to 2020	1990 to 2020
Base case	114	155	186	455
Max. nuclear	115	171	334	620
	Plutonium (curies)			
	1990 to 1999	2000 to 2009	2010 to 2020	1990 to 2020
Base case	1.6E+09	2.2E+09	2.6E+09	6.4E+09
Max. nuclear	1.6E+09	2.4E+09	4.7E+09	8.7E+09

Notes: E+09 is one US billion or 10^9

Source: Two Scenarios of Nuclear Power and Nuclear Waste Production in Northeast Asia, Case Study 97-2, Center for International Studies, Graduate School of International Studies, Yonsei University, Seoul, Korea at: http://www.nautilus.org/archives/papers/energy/dvh_hayesNukeScenarios.html

lin Island to Japan, to pipelines covering many thousands of kilometers to link Central Asia with East Asia. What virtually all these proposals share is high capital costs (a range of US$1.2 billion to US$20 billion, based on a rate of US$1-2 million per kilometer of pipeline[13, 14]), long lead times for completion (typically five years or more), and formidable technical and political barriers to implementation.

In addition, in order to be economical, the availability of gas has to coincide with demand. In China, gas distribution infrastructure remains undeveloped in many areas. Japan's gas industry is based on local distribution systems for liquefied natural gas (LNG), but lacks a national trunk pipeline system that would allow the use of substantial pipeline gas imports. South Korea has a relatively well-developed national gas transmission and distribution system, which is likely to provide a competitive economic advantage relative to Japan, if and when pipeline gas imports are available. Given the existing level of industrialization in South Korea and Japan, however, it remains to be seen whether a significant expansion of gas use is likely in either country. North Korea, whose economy has traditionally depended on coal, has essentially no gas distribution infrastructure. All of these factors argue that gas pipelines in Northeast Asia are an unlikely option in the near-term, particularly without a breakthrough in relations with North Korea.

Oil pipelines, meanwhile, have been proposed to link the oil fields of Siberia to terminals in northern China,[15] the oil fields of Russia's

A successful approach to energy sector redevelopment in North Korea requires coordinated action on many different fronts, each done on a relatively small scale.

Sakhalin area with Japan, and even oil fields in the Caspian region to consumers in China and beyond. Uncertainties about future oil market conditions, however, coupled with formidable technical barriers and capital costs reaching easily into the billions of dollars, have severely limited major pipeline development, though some Russian and multinational companies remain interested.

COOPERATION ON REGIONAL NUCLEAR WASTE MANAGEMENT

While debate continues over cost and safety issues, nuclear power is a reality in Japan, South Korea and China, and its use is likely to grow over the coming decades in those countries. Estimates of the amounts of nuclear waste from power reactors that must be stored and ultimately disposed of under "base under" and "maximum nuclear" scenarios of nuclear power development in Northeast Asia are shown in Table 3 (previous page).

The attempt by Taiwan and North Korea in 1997 to reach a deal on nuclear waste storage generated much controversy and showed the potential for this issue to create conflict. Moreover, no long-term solution to the nuclear waste problem in Japan and Korea is likely without regional collaboration involving China and Russia. This could take a number of forms ranging from the setting of regional standards for the storage, disposition, and transport of nuclear waste to the development and operation of a regional repository for nuclear waste.

This level of cooperation would allow a measure of regional control over nuclear waste issues, providing quality control and transparency in transactions. The countries and companies using regional waste repositories would provide financial transfers to the host country or countries. Of course, significant technical, financial, and environmental concerns regarding the location and operation of a regional waste storage facility must be identified; and contentious political and institutional issues will also need to be addressed before any such facility can be developed, especially if regional initiatives are to be consistent with recently announced American policies to promote cradle-to-grave nuclear fuel schemes. Until consensus on these difficult issues is achieved, nuclear waste is destined to remain in the countries where it is generated, either in national repositories, spent fuel ponds near reactors, or in dry cask storage.

COOPERATION ON RENEWABLE ENERGY, EFFICIENCY TECHNOLOGY, AND FINANCING

Renewable energy and energy efficient technologies have begun to play an important role throughout Northeast Asia. Climate change, local and regional environmental concerns, and the desire for economic development all contribute to the attractiveness of these options. The region includes countries that are leaders in developing technologies to mass-produce devices to capture and use renewable forms of energy and to increase the efficiency with which consumers use energy. The region also has the financial resources to develop and deploy these technologies to countries whose markets are eager for such alternatives.

Cooperative strategies that allow the countries of Northeast Asia to share and co-develop new technologies could result in the accelerated deployment of renewable energy sources and other alternatives to expanded fossil fuel use. Such strategies could include country-to-country grants, technical assistance, joint ventures to manufacture energy efficient and renewable energy devices, the trading of greenhouse gas emissions, and co-funding of research to co-develop key technologies.

Successful cooperation of this type would take advantage of regional economies of scale to provide greater production capacity, more rapidly and at a lower cost than would otherwise be the case. Candidates for the types of devices and equipment that might be included in regional initiatives include wind power systems; photovoltaic power systems at all scales, from households to central power stations; high-efficiency automobiles, such as lightweight hybrid cars and fuel-cell vehicles; advanced lighting technologies, motor drives, and appliances; low-polluting industrial and commercial boilers, particularly in China, North Korea and Mongolia; and cooperation on building codes to improve the thermal performance of residential and commercial buildings, especially in China, the Russian Far East, North Korea, and Mongolia.

Cooperation, of course, assumes that the rich countries, especially Japan and South Korea, would be willing to fund up-front investments in technological development. These countries would be paid back in the form of lower costs for renewable energy and energy efficiency devices at home, and partial credit for reducing greenhouse gas and/or other environmental emissions in the region. In all probability, they would also receive income from sales of the technologies. To the extent that countries in the region are technological competitors, however, some forms of collaboration could be problematic without strong regional institutions to encourage cooperation, emphasize environmental and political-security benefits, and probably protect intellectual property rights as well.

NORTH KOREA'S ENERGY INSECURITY: HIGHEST PRIORITY?

Arguably, the most urgent imperative for regional cooperation is the near-desperate energy situation in North Korea. The energy problems faced by the DPRK lie behind much of the insecurity felt about Pyongyang's behavior. These insecurities include the threat of nuclear proliferation, the risk of war on the Korean Peninsula, the use of nuclear weapons, and the specter of collapse and civil war in the North.

If South Korea, the U.S. and their partners in the Six-Party Talks can negotiate a non-violent resolution to North Korea's nuclear challenge, the addressing of energy issues will almost certainly play a key role in the outcome. The deterioration of North Korea's energy sector between 1996 and 2006 has, for the most part, been of a substantially more incremental nature than the changes the country experienced during the first half of the 1990s. Still, the situation is bleak. Among the problems:

- A continuing decline in the supply of crude oil from China, significantly reducing the overall output of North Korea's remaining major refinery, combined with a shift to commercial rather than "friendship" pricing
- Continuing degradation of electricity generation infrastructure due to a lack of spare parts, a failure to perform maintenance work, and the use of high-sulfur fuels in boilers designed for low-sulfur coal
- Continuing degradation of electricity transmission and distribution infrastructure, resulting in much-reduced availability of electricity in most parts of the country outside Pyongyang
- The virtual collapse of industrial facilities, and the damage to industrial electric motors, from poor quality electricity (electricity with highly variable voltage and frequency)
- Continuing difficulties with transport of all goods, especially coal
- Problems in coal production caused by a lack of electricity
- The flooding of mines in the Anju region

Overall, DPRK energy use has fallen by roughly half in 2006 compared to its peak in about 1990. Today, the residential sector uses an even larger share –more than half – of the overall energy budget while the industrial sector's share has shrunk to under a quarter of the total. This change is the combined result of continued reduction in fuel demand in the industrial sector (as many industrial facilities have been shut down), relatively constant use of wood and other biomass fuels in the residential sector, and reductions in the use of other residential fuels, notably coal and electricity, that have been less severe than the reductions experienced by industry. The importance of biomass fuels to the energy budget is estimated to have increased dramatically over the course of the decade, while the importance of commercial fuels has decreased. Demand for fuel has led to the diversion of available biomass into primary energy for human survival. This trend has dire implications for North Korea's soil, forests, and watersheds.

In addition, North Korea's industrial and energy-using infrastructure, including heating systems in residential and other buildings, is antiquated, based on outdated and inefficient technology. Also, a lack of fuel has apparently caused demand for energy services to go unmet. When and if supply constraints are removed, there is likely to be a surge in energy use.

Compounding the risk of a surge in demand is the virtual lack of energy-product markets in North Korea. Without further fuel pricing reforms, there will be few incentives for households and other users to adopt efficiency measures, or otherwise control their fuel consumption. Anecdotal indications are that some pricing reforms are underway, but it is not yet clear to what extent reforms have been implemented in the energy sector.

There are specific energy sector initiatives that would assist the process of rapprochement with North Korea, help get its economy and energy

NOTES

16 Drawn from David Von Hippel and Peter Hayes, "The Dprk Energy Sector: Recent Status, Problems, Cooperation Opportunities, And Constraints," workshop on "Future Multilateral Economic Cooperation With The Democratic People's Republic of Korea," sponsored by the Stanley Foundation in cooperation with the German Council on Foreign Relations (June 15, 2005)

sector working in a sustainable and peaceful manner, and pave the way for additional cooperative activities. They include:[16]

- **Assistance for economic, legal and policy reforms to stimulate and sustain energy sector rebuilding in North Korea.** This could include reform of energy pricing practices, and the physical infrastructure to implement them; capacity building for careful energy planning to allow aid to be based on rational objectives; training for people working in energy industries; strengthening regulatory agencies and educational/research institutions; and involving the private sector in investments and technology transfer.
- **Rebuilding the country's power transmission and distribution (T&D) system.** The most cost-effective approach for assistance in this area would be to start by working with North Korean engineers to identify and prioritize a list of T&D sector improvements and investments, and to provide limited funding for pilot installations – perhaps in a so-called special economic zone or other designated area.
- **Rehabilitation of power plants and other coal-using infrastructure.** The initial focus should be on improvements in small, medium, and district heating boilers for humanitarian end-uses such as residential heating.
- **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 is to increase.
- **Development of alternative sources of small-scale energy and implementation of energy-efficiency measures.** We have worked with North Koreans who have a keen interest in renewable energy and energy-efficiency technologies. This interest is consistent with both the DPRK philosophy of self-sufficiency and the practical necessities of providing power and services to local areas when national-level supply systems are unreliable, at best. Such projects should be fast, small and cheap, and should start by emphasizing agricultural and humanitarian applications.
- **Rehabilitation of rural infrastructure.** The goal of a rural energy rehabilitation program would be to provide the modern inputs necessary to allow North Korean agriculture to recover sustainable production levels and meet the basic needs of the rural population.
- **Begin transition to the use of gas with Liquid Petroleum Gas (LPG) networks.** LPG is more expensive than natural gas, but the infrastructure to import LPG, relative to liquefied natural gas (LNG), is much easier and less

Ecology

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expensive to develop, and allows imports in smaller quantities. LNG is also clean-burning and has limited potential for military diversion. Setting up LPG networks can be a first step toward the use of natural gas in the DPRK. Ultimately, natural gas pipelines and LNG terminals, shared with neighboring countries, can serve as a step toward economic development coupled with regional integration.

A successful approach to energy sector redevelopment in North Korea requires coordinated action on many different fronts, each done on a relatively small scale. Preferably, many different "actors" from outside North Korea would be involved, including non-governmental organizations, bilateral aid programs, and international organizations. They should engage a range of different organizations within the country. Doing so will not be easy, but it is necessary, because funneling many projects through a single "gateway" organization in North Korea could quickly overwhelm the organization's capacity to accept and manage projects, resulting in delays, inefficiency, and worse.

Working with North Korean counterparts to identify projects that are of most interest, while still providing the development and humanitarian benefits desired by outside donors, will also be required. The emphasis should be on projects that North Korean institutions, including local organizations, can learn from and replicate, and which help local development. Putting international experts in positions to work closely with North Korean counterparts in the field is a key element in assuring the success of such projects.

Apart from the obvious need to find a peaceful resolution to the current international crisis over North Korea's nuclear weapons program, moving forward with energy sector redevelopment will require overcoming a variety of hurdles. These include lack of financing from outside sources so long as the nuclear weapons issue remains unresolved; lack of trained counterparts within North Korea who understand international project implementation standards; the need to couple energy sector redevelopment with overall economic redevelopment, so that North Korea can fund follow-up efforts; and, finally, the need to improve the quality of information available about North Korea's real energy needs.

Getting past these hurdles will require vision on the part of the international community and an approach to aid that engages North Koreans and builds capacity at every opportunity. Above all, it will require patience and a long-term commitment.

CONCLUSION

Notably absent from the list of regional initiatives to address North Korea's energy insecurity presented above are typical large-scale, intergovernmental energy projects. These would be bound to fail. We believe regional energy security is more likely to emerge from activities that 1) build confidence between countries and communities within the region; 2) enhance social, institutional, scientific and technological capacity to manage the energy-security-environment nexus; and 3) achieve an environmental benefit which is specific and measurable in the short-term. We believe that anyone promoting energy security initiatives should be able to show that such projects:

1. **Promote Common Understanding:** An initiative should assist in creating a common understanding of energy-environment-security linkages. In part, common understanding rests on cooperative scientific assessment.
2. **Build Constituency and Political Will:** An initiative should build a broad constituency and generate political will for further regional environmental cooperation.
3. **Use Complementary Strengths:** An initiative should draw on complementary strengths of countries in the region (analytical, technological, etc.).
4. **Promote Interdependence and Mutual Interest:** An initiative should stem from recognized mutual interests in Northeast Asia, and from mutual interests, it should seek to build a sense of interdependence.
5. **Use (and Reform) Existing Institutional Channels:** If possible, the implementation of an initiative should utilize existing institutional channels rather than create new channels.
6. **Require Modest and Shared Cost:** An initiative must be financially modest, with a shared startup cost of less than half a million dollars. Over the long term, the initiative should be based on the principle that the costs of regional cooperation are borne by all parties.
7. **Be Fundable, Flexible and Sustainable:** An initiative should be one for which funding can readily be secured. In other words, it fits within the guidelines of present funding agencies. It should be flexible to allow a change of the course of implementation, and should have a durability that raises the prospects of continuation beyond an initial implementation phase.
8. **Possess Specific, Measurable Benefit and Short-Term Payback:** An initiative should have a specific and measurable benefit, so that there are well-defined benchmarks for success or failure of the initiative. Also, the initiative should have a significant short-term payback. Projects with the greatest political payoff are the most likely to be funded and to succeed.

This leads naturally to the question: who are the likely leaders and champions of such projects? Not national governments and large companies. They are likely to overlook many opportunities of this scale. Civil society organizations, individual utilities, and local and urban governments, on the other hand, are more likely to see the value in starting, and successfully implementing, such small-scale initiatives. It is from such seeds that forests grow.

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