A Trans-Korean Natural Gas Pipeline: Feasibility Study

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April 25, 2011
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I. Executive Summary

The objective of this report is to assess the feasibility of a 3200 kilometer Trans-Korean natural gas pipeline. This project would run from the urban center of Vladivostok in the Russian Far East, through the Democratic People’s Republic of Korea (DPRK), with a final destination of Seoul, the capital city of the Republic of Korea (ROK) (App. F. 2.).

To begin, South Korea, The Russian Federation, and North Korea are evaluated in respect to their current energy situations, political climate, and level of interest in an international energy scheme. Although this report recommends that the pipeline proposal be undertaken by firms, the national agendas of these countries cannot be ignored. There are several reasons for this. First, energy policy is of primary importance to all three nations. For Russia, energy exports are the cornerstone of both economic and political power. In South Korea, energy security is integral for continuing growth while in North Korea it is the lack of such energy that has been one of the primary reasons for economic stagnation. The second reason is the traditional involvement that all states have played in their energy sectors. Moreover, the firms most appropriate for undertaking this project are both controlled by state governments.

While the two firms in question are state controlled, Gazprom in the Russian Federation and the Korean Gas Corporation (KOGAS) in South Korea, a strong understanding of their fundamentals is necessary for comprehending this proposal. Thus, the next section of this paper is devoted to analyzing the suitability of Gazprom and KOGAS for this project.
Following the analysis of Gazprom and KOGAS is a detailed analysis of the project from three perspectives. The first is financial, explaining the most likely sources of capital for this proposal. Second, this report assesses how this project could be marketed to key decision makers in each country. Finally, the actual construction of the line is discussed. Along with these concerns, this paper also addresses steps that the ROK and Russia could take to mitigate the substantial political risk the DPRK presents.

This report ends with a cost/benefit analysis, estimating an NPV of $13,216,653,480.23. Despite the complications involved in constructing this pipeline, a careful analysis illustrates how lucrative this pipeline could be and suggests practical methods of risk minimization.

II. Pipeline Proposal

This report recommends the joint construction of a 3200 kilometer Trans-Korean natural gas pipeline. This project would run from the urban center of Vladivostok in the Russian Far East, through the Democratic People’s Republic of Korea (DPRK), with a final destination of Seoul, the capital city of the Republic of Korea (ROK) (App. F. 2.).

With the anticipated growth in South Korea energy demand and Russia’s untapped resources in the Far East a natural gas pipeline would be beneficial to both parties. Since the 1960’s, companies, governments, and research institutions have continually revisited the possibility of
several Russian pipelines running into Northeast Asia.\(^1\) However, many of the previously studied routes have been mired in complications, as they would have to traverse long distances and, in many cases, be laid under large bodies of water.\(^2\)

This proposal seeks to circumvent these difficulties by laying a pipeline that would run from the Russian Province of Sakhalin, down through Russia’s Southeastern provinces, and directly through the DPRK. While this plan does expose the pipeline to significant political risk, it also avoids the technological complications of having to construct undersea routes. Costs for constructing the main line of this project range from 10 billion to 14 billion USD, estimated from the projected costs of other similar initiatives that have been abandoned in the past.\(^3\)

In addition, this project would call for the construction of eight 250 megawatt gas fired power stations within North Korea.\(^4\) These stations would be positioned in locations that would allow them to easily access the main pipeline and would conceivably power small local power grids by siphoning off a set portion of the gas running through the line. This element of the project would cost an estimated additional 1.4 billion USD and would be funded through a combination of international aid donations to the state of North Korea.\(^5\) This would both give North Korea a

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\(^5\) Ibid 12
vested interest in the continued operation of the pipeline and begin a sustainable solution to the energy shortages that have plagued the DPRK in the past.

III. National Background

A. Republic of Korea

The Republic of South Korea is currently the world’s 10th largest consumer of oil and energy in the world.6 It is also the most resource deficient country in all of Northeast Asia, importing 98% of all energy supplies.7 With a population growth rate ranked 179th in the world, at .266%, South Korea’s future will include both an aging population and increased energy demands.8

Historically, South Korea has demonstrated staggering growth rates due to mass mobilization of its populace and clear government strategies focused on the development of key industries. During the time period 1960 – 1996 South Korea averaged a growth rate of more than 8% per annum.9 This trend was briefly interrupted due to the Asian Financial Crisis which sent GDP plummeting by 6.9%. However, South Korea quickly experienced a “V-Shaped” Recovery which sent its GDP growth rate soaring to 9% during the year of 1999-2000. Since 2003, South Korea has averaged more modest increases of 4-5% per annum.10(App. F. 4)

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7 Calder 2
8 CIA
9 ibid
10 Lee Kon Seong, Gento Mogi and Jong Wook Kim, “Energy Technology Roadmap for the Next 10 Years: The Case of Korea,” Energy Policy Vol 37. Issue 2 588-596 (February 2009)
As South Korea’s economy continues to grow its demand for energy is rising in tandem. In 2008 it was estimated that South Korea imported 2.982 million barrels of oil per day, consumed 440 billion Kwh of electricity, and 34 billion cubic meters of natural gas. With these figures South Korea is the world’s 10th largest oil consumer and 25th in natural gas consumption.\textsuperscript{11} Furthermore, although South Korea is anticipated to utilize much less natural gas than Japan in the next twenty years, its growth rates are more than double that of its larger neighbor (App. F.7).\textsuperscript{12}

Compounding the ROK’s growing need for energy is its deficit of natural resource endowments. In 2005 South Korea was recorded to have no proven reserves of oil, and a miniscule amount of exploitable natural gas reserves.\textsuperscript{13} Its coal endowment amounts to only 82 Megatons. By comparison, Russia has an estimated 200,580 megatons and even Japan holds 785 megatons of natural coal deposits.\textsuperscript{14} Taking into account oil, natural gas, and coal South Korea is the most resource deficient country in Northeast Asia, falling 742 megatons behind Japan in total potential energy production and 512 megatons behind North Korea (App. F.3.).\textsuperscript{15}

Currently, Korea imports an estimated 81\% of its oil from the Persian Gulf, a provider that is both geographically distant and subject to supply disruptions due to regional instability.\textsuperscript{16} Furthermore, not just South Korea but all of Asia is subject to what has been called the “Asian

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\textsuperscript{11} Calder 4
\textsuperscript{13} Cabelu 220
\textsuperscript{14} Calder 4
\textsuperscript{15} Calder 4
Premium,” or a historically higher average cost of energy resources when compared to other regions of the world. After accounting for shipping, storage, and risk premiums, it has been estimated that, on average, East Asia pays 1.5 USD more for each barrel of imported oil than the U.S. or Europe.\textsuperscript{17} This is assumed to be due to the high dependency that Asian countries have on energy rich regions; a result of their lack of domestic assets.\textsuperscript{18} While China has historically been able to mitigate some of this energy demand its high growth rate has caused China to switch from an energy exporter to that of a net importer since 1993.\textsuperscript{19} With China’s demand anticipated to outpace even its current suppliers by 2020 it is almost unthinkable that China will return to its role as an energy supplier in the future.\textsuperscript{20}

\subsection*{B. Russian Federation}

Since the collapse of the Soviet Union in 1991 the Russian Federation has shifted its focus from an isolated centrally planned economy to one that is more open and market based.\textsuperscript{21} Possessing the 9\textsuperscript{th} largest population base, the 7\textsuperscript{th} largest world economy, and the endowed with the majority of natural resources on the Asian continent, Russia is poised to play a pivotal role in the energy market of both East Asian and the world in the coming decades.\textsuperscript{22} The International Energy Agency (IEA) predicts that Russia’s influence on the global price of oil and natural gas will increase dramatically in the next two decades.\textsuperscript{23}

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\item \textsuperscript{17} Xiaojun 2
\item \textsuperscript{18} Ibid
\item \textsuperscript{19} Ibid 4
\item \textsuperscript{21} “Russia,” \textit{CIA World Factbook}, \url{https://www.cia.gov/library/publications/the-world-factbook/geos/rs.html}
\item \textsuperscript{22} Ibid
\item \textsuperscript{23} Thorton, Judith “Sakhalin Energy; Problems and Prospects,” \textit{University of Washington, Seattle}, \url{http://www.econ.washington.edu/user/thornj/SakhProbRev4.25.00.pdf}
\end{itemize}
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Since the 1998 Russian Financial Crisis, Russia has averaged a 7% growth rate per annum.\(^{24}\) (App. F. 5.) This has resulted in a doubling of discretionary income for the average Russian citizen and the rise of a sizable middle class. Although Russia was heavily affected by the 2008 financial crisis, the country quickly rebounded by 2010; posting an estimated 3.8% GDP increase.\(^{25}\) Despite continuing issues with weak property laws, regulatory complexity, and state interference prospects for continued Russian growth remain positive largely due to the expected rise in energy costs for the foreseeable future.\(^{26}\)

Since the collapse of the Soviet Union, Russia’s economy has been dependent on the energy resources it possesses. In particular growth from 2000-2008 was driven by the spike in oil and gas prices resulting from the instability in the Middle East.\(^{27}\) In 2009, Russia was the world’s largest exporter of natural gas and the second largest exporter of petroleum. With the world’s largest estimated reserves of natural gas, at 47.57 trillion cubic meters, Russia’s importance in this industry will only continue to grow.\(^{28}\) (App. F. 6) It was estimated by the IEA that if Russia were to construct a robust pipeline infrastructure with Northeast Asia it could easily meet the region’s growing demand for energy resources in the next half century.\(^{29}\)


\(^{25}\) CIA

\(^{26}\) Godzmirski Jakub and Nina Poussenkova, “Russia’s New Gas Projects,” Center for Strategic Studies and Conflict Research, Swiss Federal Institute of Technology (April 21 2009

\(^{27}\) Ibid 3

\(^{28}\) The Economic Times

Russia is also looking to diversify the market for its energy products. Currently, 63% of all Russian gas is exported to the European Union.\(^{30}\) Because of this, 45% of all the EU’s gas consumption is supplied by the Russian Federation, or more specifically, Gazprom as it is the only company that is authorized to export Russian natural gas.\(^{31}\) Furthermore, in the future Russia anticipates being able to meet as much as 70% of total European natural gas consumption by 2020 and Gazprom hopes to have captured 33% of the entire natural gas market in the EU by 2015.\(^ {32}\)

This energy trade between the EU and Russia has created a mutual dependency that neither country, particularly the EU, is comfortable with. The leverage that Russia gained from acting as the dominant supplier of natural gas was made obvious in 2009 when Russia’s dispute with Ukraine caused a cessation of natural gas shipments to the EU for a total of two weeks. As 70% of Russian gas to the EU is shipped through Ukraine, this disruption was both significant and jarring for the EU.\(^{33}\) Other incidents have been Russia’s frequent disagreements on royalties with President Alexander Lukashenko of Belarus and Russia’s use of preferential gas tariffs to make political statements, particularly in regard to Poland.\(^{34}\) On the Russian side, post financial crisis the stability of EU demand has been less than reliable. In 2009 Gazprom announced that it would be decreasing its output by 10% to adjust for falling demand.\(^{35}\) This decrease led to a significant drop in Gazprom profitability estimated to be between 63-91 billion USD.\(^{36}\) With Russia

\(^{30}\) Godzmirski 3
\(^{31}\) Ibid 7
\(^{32}\) Ibid 3
\(^{33}\) Bomberg Elizabeth et. al., *The European Union: How Does It Work?* (Oxford University Press 2008)
\(^{34}\) Ibid 78
\(^{35}\) Godzmirski 4
\(^{36}\) Ibid
increasingly looking to bolster its economy on international energy exports, this fluctuation in demand is a cause for real concern.

In order to mitigate this risk the EU has plans to integrate its natural gas infrastructure to make it more difficult for Russia to choose which countries receive its natural gas.\textsuperscript{37} The European Union has also begun to negotiate as a bloc with Gazprom, to further reduce the chance of price differentials between member nations.\textsuperscript{38}

As the EU takes steps to lessen the leverage Russia holds as an energy supplier, Russia could gain additional power by opening up a robust trade with the Northeast Asian sphere. This would have the benefit of giving Russia options as to where it chooses to export its energy supplies, negating some of the gains the EU would accumulate with collective bargaining arrangements.

\textbf{C. Democratic People’s Republic of Korea}

Immediately following the end of the Korean War in 1953, The Democratic People’s Republic of Korea’s (DPRK) economy was relatively prosperous, bolstered by heavy subsidies from both the Soviet Union and China.\textsuperscript{39} However, entering into the 1990’s the collapse of the USSR had disastrous effects on North Korea’s economy. Starting in 1989 the USSR and China began demanding hard currency for all oil products shipped into North Korea.\textsuperscript{40} This was the first of many events that lead to the rapid decline of the DPRK’s economic activity. From 1900-1995

\textsuperscript{37} Bomberg 81
\textsuperscript{38} Ibid
\textsuperscript{39} Bertil Lintner, Great Leader, Dear Leader: Demystifying North Korea Under the Kim Regime, \textit{Silkworm Books}, 2005
\textsuperscript{40} Ibid 32
exports to North Korea fell by more than 50%, freezing up industrial activity due to a lack of energy inputs.\textsuperscript{41}

Today, North Korea’s economy is in dismal condition. Its capital stock is almost beyond help, suffering from disrepair due to lack of parts, technical expertise, and poor maintenance.\textsuperscript{42} Its 2010 estimated GDP was 40 billion, with a real growth rate of -.9%.\textsuperscript{43} North Korea only real exports are military technologies to a select few pariah nations and hard drugs such as opium and methamphetamines to the Chinese market.\textsuperscript{44} Further, with an estimated 46.7% of GDP dependent on energy intensive industries such as fertilizer production, petrochemicals, and steel factories North Korea’s chronic energy shortages have had severe effects on its ability to sustain any kind of legitimate economic activity.\textsuperscript{45}

Like South Korea, the DPRK’s has few natural resources to tap within its own borders. A notable exception to this is coal; the DPRK has an estimated 600 megatons of estimated coal reserves.\textsuperscript{46} Because of decreasing imports of oil, North Korea has become increasingly reliant on its coal reserves to meet both its industrial and consumer energy needs. However, the coal is of uneven quality and frequently results in complications when burned for fuel in the many coal fired power plants around the country.\textsuperscript{47} By some estimates North Korea loses as much as 50% of the effective energy of its coal due to inefficiencies in its power structure.\textsuperscript{48}

\textsuperscript{41} Oberdorfer Don, The Two Koreas, \textit{New York Basic Books}2009
\textsuperscript{42} “Korea, North” \textit{CIA World Factbook}, \url{https://www.cia.gov/library/publications/the-world-factbook/geos/kn.html}
\textsuperscript{43} Ibid
\textsuperscript{44} Haggard Stephan and Marcus Noland, Famine in North Korea: Markets, Aid, and Reform, \textit{Columbia University Press} 2009
\textsuperscript{45} Paik Keun-Wook, “Low on Power,” \textit{World Today}, vol. 57 iss. 2 (February 2001)
\textsuperscript{46} Calder 4
\textsuperscript{47} Paik
\textsuperscript{48} Ibid
Although North Korea is notorious for its adversity to the international community its dependence on international aid has ironically increased the more it attempts to follow its isolationist policies. In 2006, an estimated 86% of all North Korea energy supplies were a result of Chinese aid donations.\textsuperscript{49} While North Korea will remain adverse to outside intervention for the foreseeable future, it is also becoming apparent how dire the economic situation is for both the regime and the country as a whole. As North Korea’s increasingly aggressive actions result in decreasing amounts of international attention and aid, it is conceivable that the DPRK will soon have no choice but to be more open to legitimate methods of economic stimulation. This is particularly salient after the release of classified State Department documents hinting that China may not be as supportive of North Korea as it once was.\textsuperscript{50} Should North Korea lose its largest benefactor it will soon have no choice but to pursue alternative methods of raising capital.

IV. Corporate Background

A. Gazprom

Gazprom was formed in 1989 when the former USSR Ministry of Gas and Industry transformed itself into a publicly held private company, retaining control over all of its previous assets.\textsuperscript{51} Upon its initial conception, the Russian Federation held a 100% stake in Gazprom. While it has since been opened up to private investment, the Russian government still controls a 50.002% controlling stake in the company.\textsuperscript{52}

\begin{footnotesize}
\begin{enumerate}
\setcounter{enumi}{48}
\item Haggard and Noland 102
\item Tisdall Simon, “Wikileaks Cable Reveals China ‘ready to abandon North Korea’,” \textit{The Guardian}, (November 29, 2010) \url{http://www.guardian.co.uk/world/2010/nov/29/wikileaks-cables-china-reunified-korea}
\item “About Gazprom,” Gazprom, \url{http://www.gazprom.com/about/}
\item Thorton 13
\end{enumerate}
\end{footnotesize}
Like its counterpart in South Korea, Gazprom is not only the best choice for the Russian side of this project, it is the only choice. Because of the 2006 Law on Gas Exports, Gazprom is currently the only company legally entitled to export natural gas originating from fields located within the Russian Federation to foreign governments and consumers. Furthermore, even if other providers were allowed to export to foreign nations, all are dependent on Gazprom in some manner, usually through the need to utilize Gazprom’s vast network of pipelines to transport their gas. Currently, Gazprom produces 580 bcm/yr of natural gas while all other companies combined extract only 115 bm/yr. In other words, Gazprom accounts for 85% of total natural gas production in Russia.

Supplementing Gazprom’s vast network of resources is the stake the Russian government holds in this company. While state involvement may prove to be a hindrance in certain projects, it would be a significant benefit for this project. Unlike other ventures, where private innovation and market competition are preferred, state involvement would bolster the element most needed for a Trans-Korean pipeline, security. Unlike a private enterprise, the Russian Federation holds the coercive resources that may be necessary to encourage a reluctant DPRK to cooperate should complications arise during the life of the project. Further, competition in the energy industry is already quite limited in Russia and South Korea, and nonexistent in North Korea thus the monopolistic tendencies that state participation tends to encourage in industry would not significantly alter the existing business environment.

53 Godzmirski 4
54 Ibid 7
55 Ibid 7
Most significant, is Gazprom’s expertise in the natural gas industry. Gazprom is the world’s largest extractor of natural gas and currently operates the largest pipeline network, the Unified System of Gas Supplies (USGS), spanning 158,200 kilometers and over twenty countries.\(^{56}\) Gazprom also controls 268 gas compressor stations, 24 underground storage facilities, and 6 gas condensate plants.\(^{57}\) This allows Gazprom not only to satisfy large quantities of demand but also to effectively control the actions of all other gas producers within the Russian State. Therefore, to work with any other producer would make little sense as Gazprom would eventually have to be dealt with. Further, in 2009 Gazprom’s total natural gas production was 549.7 billion cubic meters (BCM) or 17% of total world production.\(^{58}\)

While Gazprom’s traditional operations center on the western provinces of Siberia and the supply of European demand there are signs that the company is laying the groundwork for supplying the growing market of Northeast Asia. In 2006 Gazprom sign an agreement with Royal Dutch Shell, Mitsui, and Mitsubishi, purchasing an interest in the Sakhalin Development Fund for the Sakhalin-2 pipeline exploration project.\(^{59}\) This project’s primary goal is to explore ways in which Russia’s largely untapped natural gas fields of the Far East can be utilized to provide energy to the Northeast Asian countries, particularly China, Japan, South Korea, and Taiwan.\(^{60}\) In 2005 Gazprom also acquired 72.7% of Sibneft, a company licensed to work on Sakhalin and Krasnoyarsk Krai.\(^{61}\) Finally, in spring 2008 Gazprom was granted access to the Chayandinsk Fields in Yakutiya, the Kirinsk field in Sakhalin, and eight fields on the Yamal

\(^{56}\) Godzmirski 3  
\(^{57}\) Ibid 2  
\(^{59}\) Thorton 14  
\(^{60}\) Ibid  
\(^{61}\) Godzmirski 6
peninsula. Currently, Gazprom has not only been exempt from taxes on these fields but is the only company with the rights to initial exploration.  

**B. Korea Gas Corporation (KOGAS)**

Established by the South Korean government in 1983 the Korea Gas Corporation (KOGAS) is the world’s single largest importer of natural gas. As South Korea’s sole provider of natural gas, KOGAS operates three regasification terminals and 2,721 kilometers of pipeline within South Korea. Its primary function is to convert the imported Liquefied Natural Gas (LNG) from liquid to gas and then to distribute that product to gas utility companies, city gas stations, and power generation plants in South Korea. Similar to Gazprom, KOGAS is a publicly held company, with 51% of its stock owned by the Korean National Government. Also similar to Gazprom, KOGAS is the only truly viable alternative for a large scale transnational pipeline project. However, unlike Gazprom KOGAS is not the most likely company due to regulations; it is simply the only company in South Korea that is both involved in the natural gas sector and large enough to support such a significant undertaking.

In addition to having industry expertise KOGAS is already in control of an effective and elaborate distribution network within Korea. This consideration is key as the existence of such a network significantly cuts down on the cost of bringing natural gas to consumers. A counter example is Japan which currently does not have an advanced natural gas infrastructure. The

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62 Ibid 6
64 Ibid
65 Ibid
government of Japan estimates that to create one would cost anywhere from 12 – 40 billion dollars. Considering that estimates for building the main pipeline run anywhere from 20 -24 billion, the cost of having to create an internal structure would more than double the necessary initial capital outlay.

V. Proposal Analysis

A. Finance

As both Gazprom and Korea Gas Corporation are state owned companies, primary financial support would be expected to originate from the national governments of Russia and South Korea. The historical tendency of both countries to support their energy industries would suggest that, even if these were private companies, heavy state involvement would be inevitable.

In South Korea, corporations such as KOGAS have traditionally been referred to as Chaebols, or large conglomerates that are given preferential treatment by the national government. KOGAS compliment, the Korean Electric Power Company (KEPCO), is also a state owned apparatus and is responsible for providing electricity to the entire South Korean nation. While both KOGAS and KEPCO are scheduled to be broken up into smaller firms to foster competition, neither entity has gone through any serious steps toward this goal. Since KEPCO has supposedly been going

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69 Ibid 569
through “privatization” since 1998 it is a reasonable assumption that neither will be going through any significant change in the immediate future.\textsuperscript{70}

Compounding the South Korean government’s likelihood to finance this activity is the flagship program of the Lee Myung Bak administration. In 2008 President Lee Myung Bak announced his “Low Carbon Green Growth” initiative, with the intent to invest an estimated 200 billion dollars from 2010 – 2015 on green energy initiatives.\textsuperscript{71} As natural gas is one of the most efficient and clean energy sources available for mainstream energy usage, investing in this pipeline would be well aligned with the current trajectory of this administration.\textsuperscript{72}

Russia’s interest in Gazprom’s success is in large part, an interest in the success of Russia as a whole. In 2008 Gazprom revenues accounted for an estimated 10\% of Russia’s entire GDP.\textsuperscript{73} Further, Gazprom accounted for 83\% of Russia’s total energy output in 2008. It is the vehicle through which Russia exerts the majority of its foreign policy leverage, in the form of threats to cut off European energy supplies, such as it did when it temporarily closed off gas pipelines to Ukraine in 2009.\textsuperscript{74} Russia has also designated Gazprom a “national champion” corporation, meaning that Gazprom makes decisions not only for the sake of its shareholders but with the

\textsuperscript{70} OECD Review of Innovation Policy: Korea 2009” Source OECD vol. 2009 no. 14 1-268  
http://titania.sourceoecd.org.proxyau.wrlc.org/vl=2427292/d=13/nw=1/rpsv/~6681/v2009n14/s1/p1l

\textsuperscript{71} Lee Kon Seong, Gento Mogi and Jong Wook Kim, “Energy Technology Roadmap for the Next 10 Years: The Case of Korea,” Energy Policy Vol 37. Issue 2 588-596 (February 2009)

\textsuperscript{72} Ibid 590

\textsuperscript{73} Gazprom

\textsuperscript{74} Bomberg 78
greater interests of Russia as a whole in mind. In exchange for this Gazprom enjoys implicit
government backing and explicit benefits such as tax breaks and fee waivers.

**B. Marketing**

Advertising this pipeline poses significant challenges for all three national governments
involved. It will require both careful coordination and delicate handling of several politically
sensitive subjects in order to both effectively convey the benefits of this collaboration while
addressing the justifiable concerns of all national citizenries involved.

i. South Korea

The most significant obstacle that will need to be overcome in South Korea will be convincing
the Grand National Party (GNP), which holds a majority in the 18th Assembly, or Korea’s
version of Congress. Traditionally conservative and hawkish toward North Korea the GNP was
responsible for curtailing all aid to North Korea soon after gaining a majority in the Assembly in
2008. After the sinking of the Korean submarine, The Cheonan, in March and the shelling of
the border island Yeongpyeong in November, convincing the GNP to fund a Trans-Korean gas
pipeline will require a significant investment of political capital.

Lee Myung Bak’s administration will need to stress two major points for this project. The first is
that it is primarily an initiative to bolster South Korea’s long term energy sustainability, not an
aid program for North Korea. The second element President Lee Myung Bak must focus on are

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75 Thorton 2
76 Ibid
77 “South Korean Political Parties Unite Against Yeonpyeong Bombardment,” *Arirang*, Nov. 23rd 2010,
http://www.arirang.co.kr/News/News_View.asp?nseq=109410&code=Ne2&category=2
the natural incentives built into the program to prevent North Korea from seizing control of the pipeline or disrupting the flow of gas to South Korea. With two acts of North Korean aggression so recent in history, the second point, the assurance of security, must take precedence when presenting this idea to the Assembly.

ii. Russia

Russia will also need to convince its constituents that North Korea does not pose a significant enough security threat to overshadow the attractiveness of this project. However, unlike South Korea, Russia’s Doma does not need to approve the appropriation of funds, making it much easier for Russia to approve financing of this project.\(^{78}\)

The main question Russian proponents of this project will need to address is the need to diversify its markets into Northeast Asia. Currently, Russia enjoys growing demand from Europe for its energy resources. In fact, the majority of Russian energy is focused on improving supply lines to the European Union, with two major pipelines planned, Nord Stream and South Stream.\(^{79}\) Russians in favor of an Asian Pacific pipeline will need to convince their constituents that the growing economies of Asia offer substantial long term opportunities for Russian energy concerns.

iii. North Korea

Being one of the most autocratic governments in existence, North Korea does not have any national constituency it needs to convince in order to agree to this pipeline project. Furthermore,

\(^{78}\) CIA

\(^{79}\) Bomberg 81
with a state budget estimated at 3.3 billion for 2009 it is unlikely that North Korea can even be expected to contribute to the financing of the eight 250 megawatt gas fired plants that will bring benefit only to North Korean homeowners.\textsuperscript{80}

Despite this North Korea remains the most challenging country to cooperate with. Because of the clandestine nature of its political system there is no real method of identifying who holds the power within North Korea to approve a project such as this. For North Korean’s who would support such a plan they would need to first assure fellow power brokers that this pipeline would neither jeopardize North Korea’s sovereignty or serve as a conduit for western interference in its internal affairs.\textsuperscript{81} North Koreans would also need to be assured that the aid for the construction of the eight power plants would be continued until the projects were completed. The last aid based energy projects, two 1000 megawatt Light Water Reactors, were abandoned half finished by the Japanese and Korean authorities after North Korea revealed its continuing nuclear program in 2002.\textsuperscript{82}

If North Korea could be assured of its sovereignty and guaranteed the benefits of allowing a Trans-Korean pipeline, securing their cooperation would be much more likely.

C. Construction and Operation

Construction of the main pipeline will only be part of the process of successfully moving Sakhalin gas deposits into South Korean homes. First, a system of pipes within Siberia must be

\textsuperscript{80} Paik  
\textsuperscript{81} Sung Chull Kim and David Kang, Engagement with North Korea: A Viable Alternative, \textit{State University of New York Presss}, 2009  
\textsuperscript{82} Funabashi Yoichi, The Peninsula Question: A Chronicle of the Second Korean Nuclear Crisis, \textit{The Brookings Institute} 2007
developed to move gas from several disparate fields toward one central station where it can be funneled into the main line. Second, South Korea will need to have a sophisticated distribution system set up in order to move gas from the main line into the city and corporate utility stations that will then distribute it to local consumers.

To complete the network of Siberian pipeline Russia has already committed to spending an estimated 25-30 billion USD to construct an integrated system that in their words, “will be friendly to robust energy exports.” South Korea already has made significant investments into a natural gas infrastructure and has consolidated all assets under the control of KOGAS.

The construction of the actual pipeline should be overseen by Gazprom in Russia, KOGAS in South Korea, and be a joint effort within North Korea. Should Gazprom head up the construction within Russia any foreign companies participating will enjoy “joint partner” status that will both simplify Russian regulations and bring down the cost of administrative fees. Because very little of the main line will actually be constructed in South Korea (Seoul is only 40 kilometers away from the De-Militarized Zone separating North and South Korea) KOGAS can logically handle a construction project of that scale on its own.

Construction of the pipeline in North Korea can be modeled after the arrangements that have been utilized in the Kaesong Industrial Complex, the only site where South and North Korean

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83 Thorton 9
84 KOGAS
85 “North Korea to host Russian Gas Pipeline?,” United Press International, (July 31, 2009)
86 KOGAS
business ventures have jointly operated since the end of the Korean War.\textsuperscript{87} Kaesong, begun as part of previous South Korean President Kim Dae Jung’s Sunshine Policy, operates with South Korean firms supplying capital and management while North Korea provides largely unskilled labor.\textsuperscript{88} While this project has been more a symbol than a serious economic asset, its model could prove useful when planning the construction of a Trans-Korean pipeline.

\textbf{VI. Cost Benefit Analysis}

\textbf{A. Costs}

 Costs for constructing pipelines from Russia to Northeast Asia have traditionally fallen within the range of 18 billion -24 billion USD. However, these plans almost all call for some portion of the pipeline to be run under large bodies of water, raising both the expense and technical complexity of the projects. They are also inevitably longer, due to the necessity of circumventing either geographical obstacles or politically risky areas.\textsuperscript{89}

Therefore, the cost of pipeline construction if run directly from Southeast Russia through North Korea would be significantly smaller. Based on a study done of 893 U.S. pipeline projects over a 13 year time span average costs of typical pipeline construction include:\textsuperscript{90}

\begin{enumerate}
\item material costs- 26\%
\item labor costs- 45\%
\end{enumerate}

\textsuperscript{87} Oberdorfer 229
\textsuperscript{88} Ibid 229
\textsuperscript{89} Thorton 16
\textsuperscript{90} Parker Nathan, “Using Natural Gas Pipeline Cost to Estimate Hydrogen Gas Pipeline Cost,” \textit{Institute of Transportation Studies UC Davis}, (December 2004) \texttt{http://pubs.its.ucdavis.edu/publication_detail.php?id=197}
3. right of way - 22%
4. miscellaneous* - 7*

* includes including surveying, engineering, supervision, contingency allowances, overhead, and filing fees

The same study offers general equations to estimate the cost of a typical pipeline project. The equations are all functions of two variables.\(^91\)

1. Project Length - for this project the length has been estimated to be 3200 kilometers
2. Pipe Diameter - For this project a diameter of 36 inches will be assumed as it is the most common for natural gas systems.

Specific Calculations-

* All equations assume cost is in dollars, diameter is measured in inches, and length in kilometers

i. Material Cost

Material Cost (diameter, length) = 330.5(dia)^2 + 687(dia) + 26,920(length) + 35,000\(^92\)

Total Material Cost= $2,566,320,060.00 USD

\(^91\) Parker 9
\(^92\) Ibid 11
ii. Labor Cost

Labor Cost (diameter, length) = 343(dia)^2 + 2074(dia) + 170,013(length) + 185,000

Total Labor Cost = $5,144,745,792.00

iii. Right of Way

Right of Way Cost (diameter, length) = (577(dia)^2 + (29,78)length + 40,000

Total Right of Way Cost = $2,096,109,392.00

iv. Miscellaneous Costs

Misc. Costs (diameter length) = (8,417(dia) + (7324)length + 95,000

Total Miscellaneous Cost = $823,834,812.00

TOTAL ESTIMATED PROJECT COST = $10,631,010,000.00 USD

B. Revenue

To simplify this equation, it is assumed that pipeline will operate at optimal capacity year round and that all natural gas forwarded to South Korea will be consumed. It is also assumed, for simplification and to avoid analyst bias, that the spot price of natural gas will remain the price of gas for the duration of this project.

1. Anticipated total output = 750,000,000 tons/yr

---

93 Ibid 13
94 Ibid 14
95 Ibid 17
For recent pipeline proposals this number has oscillated between 750,000,000 tons/yr - 1,000,000,000 tons/yr. For this initial revenue estimation we will use the conservative estimate of 750,000,000 tons/yr.

2. Current International Spot Price of Natural Gas = $4.37 USD/MMbtu

3. According to a unit conversion table (see appendix) one ton is equivalent to 48.7 MMbtu thus:

   Price/Ton of Natural Gas = $213.01 USD

4. Total Revenue (per annum)

   = Price/Ton of Natural Gas * Total Expected Output

**TOTAL EXPECTED REVENUE (Per Annum) = $1,597,603,500.00 USD**

C. Project Evaluation

To evaluate the attractiveness of this project the Net Present Value (NPV) is calculated. For this initial calculation, cash flows are assumed to be constant throughout the life of this project.

---

96 Economic Times
Furthermore, as similar pipelines in discussion have an expected life of thirty years it is assumed the project will see thirty years of steady cash flows.

To estimate the cost of capital it is assumed that this project will be jointly funded by the Russian Federation and the South Korean National Government. Thus to compute the cost of capital the interest rate was found for ten year Russian (.06%) and ten year South Korean (.0452%) bonds. Assuming that the costs are shared evenly, the estimated cost of capital for this project was found to be 5.26%.

**TOTAL ESTIMATED NPV = $13,216,653,480.23**

**VII. Concluding Remarks**

A Trans-Korean Pipeline has benefits that cannot be quantified. By bringing North Korea into the broader global community it will increase security across the Northeast Asian sphere. Within North Korea a pipeline could act as both the beginning of a legitimate economy and a way for the more than 23 million impoverished North Korean’s to access heat and electricity for vital needs such as warmth and the running of medical equipment. In time, this could lead to a more robust North Korean economy that would not only make its nuclear program redundant, but lessen the possibility of nuclear proliferation by transforming North Korea from a pariah state into an actor with a stake in global security.

In the context of Russia, an Asian Pacific option would allow it to leverage a diversified demand portfolio into higher gas prices. Further, it would allow Russia to begin utilizing the energy
resources of the Far East which up to now have been too geographically distant to serve as viable options for foreign markets. For South Korea, it would mean a stable energy supply that does not have to be shipped halfway around the globe. These benefits are not captured in the NPV analysis conducted above. All three nations have much to gain from this proposal. While the investment may seem significant, it is nothing compared to the possible benefit it could bring to both these nations and their people.
Appendix

Figure 1. Map of Northeast Asia

Figure 2. Pipeline Proposal
### Figure 3. Northeast Asian Natural Resource Endowment

Table 1. Energy Reserves of the Northeast Asian countries

<table>
<thead>
<tr>
<th></th>
<th>Coal</th>
<th>Oil</th>
<th>Natural Gas</th>
<th>Hydropower</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Proven Reserves (Mton)</td>
<td>Proven Reserves (Mton)</td>
<td>Proven Reserves (Bil.m)</td>
<td>Technically Exploitable Capability (TWh/yr)</td>
</tr>
<tr>
<td>S. Korea</td>
<td>82</td>
<td>-</td>
<td>6</td>
<td>55</td>
</tr>
<tr>
<td>N. Korea</td>
<td>600</td>
<td>-</td>
<td>-</td>
<td>N/A</td>
</tr>
<tr>
<td>Japan</td>
<td>785</td>
<td>7</td>
<td>32</td>
<td>134</td>
</tr>
<tr>
<td>China</td>
<td>95,900</td>
<td>5,272</td>
<td>1,171</td>
<td>1,923</td>
</tr>
<tr>
<td>Mongolia</td>
<td>10,000</td>
<td>-</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>Russia (RFE &amp; E. Siberia)</td>
<td>(200,580)*</td>
<td>6,654</td>
<td>47,700</td>
<td>1,670</td>
</tr>
<tr>
<td>NE Asia Total (a)</td>
<td>(169,300)*</td>
<td>(1,570)*</td>
<td>(3,204)*</td>
<td>(1,008)**</td>
</tr>
<tr>
<td>(share a/b)</td>
<td>(39.1%)</td>
<td>(8.2%)</td>
<td>(33.2%)</td>
<td>(26.5%)</td>
</tr>
<tr>
<td>World Total (b)</td>
<td>788,511</td>
<td>146,102</td>
<td>147,265</td>
<td>14,284</td>
</tr>
</tbody>
</table>

### Figure 4. South Korean Economic Growth

**IMF Data Mapper ®**

Real GDP growth (Annual percent change)

Figure 5. Russian Federation Economic Growth

IMF Data Mapper®

Real GDP growth (Annual percent change)


Figure 6. Natural Gas Resource Distribution

Global Distribution of Proven Natural Gas Reserves
©2009 “Ranking America” (http://rankingamerica.wordpress.com)

Data from CIA World Factbook 2008
Figure 7. Northeast Asia Natural Gas Consumption Projection

Figure 8. Russian Natural Gas Consumption Projection
Figure 9. Non-OECD Natural Gas Production Projection

Figure 46. Non-OECD Europe and Eurasia natural gas production, 1992-2035
(trillion cubic feet)
Figure 10. Gazprom Balance Sheet

<table>
<thead>
<tr>
<th>Notes</th>
<th>30 September 2010</th>
<th>31 December 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assets</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current assets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Cash and cash equivalents</td>
<td>315,832</td>
<td>249,759</td>
</tr>
<tr>
<td>6 Restricted cash</td>
<td>3,658</td>
<td>4,872</td>
</tr>
<tr>
<td>7 Short-term financial assets</td>
<td>19,901</td>
<td>52,137</td>
</tr>
<tr>
<td>8,24 Accounts receivable and prepayments</td>
<td>668,266</td>
<td>846,725</td>
</tr>
<tr>
<td>9 Inventories</td>
<td>333,859</td>
<td>286,719</td>
</tr>
<tr>
<td>VAT recoverable</td>
<td>122,586</td>
<td>144,691</td>
</tr>
<tr>
<td>Other current assets</td>
<td>160,619</td>
<td>107,044</td>
</tr>
<tr>
<td><strong>Non-current assets</strong></td>
<td>1,624,721</td>
<td>1,691,947</td>
</tr>
<tr>
<td>10,25 Property, plant and equipment</td>
<td>5,245,555</td>
<td>4,899,223</td>
</tr>
<tr>
<td>11 Investments in associated undertakings and jointly controlled entities</td>
<td>827,073</td>
<td>794,705</td>
</tr>
<tr>
<td>12 Long-term accounts receivable and prepayments</td>
<td>423,387</td>
<td>413,309</td>
</tr>
<tr>
<td>13 Available-for-sale long-term financial assets</td>
<td>85,197</td>
<td>106,658</td>
</tr>
<tr>
<td>14 Other non-current assets</td>
<td>482,353</td>
<td>462,686</td>
</tr>
<tr>
<td><strong>Total assets</strong></td>
<td>7,063,565</td>
<td>6,676,581</td>
</tr>
<tr>
<td><strong>Liabilities and equity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current liabilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accounts payable and accrued charges</td>
<td>547,358</td>
<td>502,075</td>
</tr>
<tr>
<td>Profit tax payable</td>
<td>7,687</td>
<td>37,267</td>
</tr>
<tr>
<td>Other taxes payable</td>
<td>64,013</td>
<td>71,934</td>
</tr>
<tr>
<td>Short-term borrowings and current portion of long-term borrowings</td>
<td>220,673</td>
<td>424,855</td>
</tr>
<tr>
<td>Short-term promissory notes payable</td>
<td>5,399</td>
<td>11,761</td>
</tr>
<tr>
<td><strong>Non-current liabilities</strong></td>
<td>845,130</td>
<td>1,047,892</td>
</tr>
<tr>
<td>15 Long-term borrowings</td>
<td>1,065,196</td>
<td>1,184,457</td>
</tr>
<tr>
<td>Long-term promissory notes payable</td>
<td>1</td>
<td>4,592</td>
</tr>
<tr>
<td>22 Provisions for liabilities and charges</td>
<td>148,626</td>
<td>143,591</td>
</tr>
<tr>
<td>16,25 Deferred tax liabilities</td>
<td>357,945</td>
<td>321,524</td>
</tr>
<tr>
<td>Other non-current liabilities</td>
<td>23,028</td>
<td>17,151</td>
</tr>
<tr>
<td><strong>Total liabilities</strong></td>
<td>1,594,796</td>
<td>1,671,315</td>
</tr>
<tr>
<td><strong>Equity</strong></td>
<td>2,439,926</td>
<td>2,719,207</td>
</tr>
<tr>
<td>17 Share capital</td>
<td>325,194</td>
<td>325,194</td>
</tr>
<tr>
<td>17 Treasury shares</td>
<td>(104,204)</td>
<td>(104,204)</td>
</tr>
<tr>
<td>Retained earnings and other reserves</td>
<td>5,710,679</td>
<td>5,105,525</td>
</tr>
<tr>
<td>5,931,669</td>
<td>5,326,515</td>
<td></td>
</tr>
<tr>
<td>Non-controlling interest</td>
<td>316,691</td>
<td>322,806</td>
</tr>
<tr>
<td><strong>Total equity</strong></td>
<td>6,248,360</td>
<td>5,649,321</td>
</tr>
<tr>
<td><strong>Total liabilities and equity</strong></td>
<td>8,688,286</td>
<td>8,368,528</td>
</tr>
</tbody>
</table>
## Figure 11. Korea Gas Corporation Balance Sheet

### Consolidated Statements of Financial Position

As of December 31, 2009 and 2008  
(In millions of Korean Won and thousands of U.S. dollars, except share data)

<table>
<thead>
<tr>
<th></th>
<th>Note</th>
<th>2009 (Won)</th>
<th>2008 (Won)</th>
<th>2009 (U.S. dollars)</th>
<th>2008 (U.S. dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assets</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cash and cash equivalents</td>
<td>4,17</td>
<td>219,774</td>
<td>552,469</td>
<td>188,227</td>
<td>473,166</td>
</tr>
<tr>
<td>Government grants</td>
<td></td>
<td>(3,888)</td>
<td>(5,264)</td>
<td>(3,330)</td>
<td>(4,508)</td>
</tr>
<tr>
<td>Short-term financial instruments</td>
<td>4,13</td>
<td>38,400</td>
<td>3,428</td>
<td>32,888</td>
<td>2,936</td>
</tr>
<tr>
<td>Trade accounts receivable, less allowance for doubtful accounts of ¥1,044,000 (US$20,589) in 2009 and ¥20,844 (US$17,852) in 2008</td>
<td>19,35</td>
<td>4,533,199</td>
<td>4,047,387</td>
<td>3,882,493</td>
<td>3,466,416</td>
</tr>
<tr>
<td>Other accounts receivable</td>
<td>9,17</td>
<td>1,852,433</td>
<td>1,810,750</td>
<td>1,586,530</td>
<td>1,550,831</td>
</tr>
<tr>
<td>Prepaid expenses</td>
<td></td>
<td>26,254</td>
<td>30,597</td>
<td>22,485</td>
<td>26,205</td>
</tr>
<tr>
<td>Special consumption tax refundable</td>
<td>105,087</td>
<td>151,450</td>
<td>90,003</td>
<td>129,711</td>
<td></td>
</tr>
<tr>
<td>Inventories</td>
<td>5,10</td>
<td>1,641,318</td>
<td>3,261,739</td>
<td>1,405,719</td>
<td>2,793,541</td>
</tr>
<tr>
<td>Current portion of derivative financial instruments</td>
<td>21</td>
<td>283,941</td>
<td>38,384</td>
<td>243,183</td>
<td>32,874</td>
</tr>
<tr>
<td>Other current assets</td>
<td>7,17</td>
<td>56,352</td>
<td>393,653</td>
<td>48,263</td>
<td>337,146</td>
</tr>
<tr>
<td><strong>Total current assets</strong></td>
<td></td>
<td><strong>8,752,870</strong></td>
<td><strong>10,284,593</strong></td>
<td><strong>7,496,461</strong></td>
<td><strong>8,808,318</strong></td>
</tr>
<tr>
<td>Long-term trade accounts receivable, less present value discount of ¥7,200 (US$617) in 2009 and ¥9,923 (US$790) in 2008</td>
<td>19</td>
<td>4,145</td>
<td>5,568</td>
<td>3,550</td>
<td>5,103</td>
</tr>
<tr>
<td>Long-term notes, less allowance for doubtful accounts of ¥1,500 (US$24,388) in 2009 and ¥2,000 (US$21,411) in 2008 and present value discount of ¥2,100 (US$17) in 2009 and ¥3,300 (US$28) in 2008</td>
<td>17,19,35</td>
<td>258,565</td>
<td>194,963</td>
<td>221,450</td>
<td>166,978</td>
</tr>
<tr>
<td>Long-term investment securities</td>
<td>6</td>
<td>251,370</td>
<td>248,665</td>
<td>215,288</td>
<td>212,971</td>
</tr>
<tr>
<td>Equity method accounted investments</td>
<td>8,35</td>
<td>106,432</td>
<td>54,168</td>
<td>91,155</td>
<td>46,393</td>
</tr>
<tr>
<td>Property, plant and equipment, net</td>
<td>32</td>
<td>10,159,885</td>
<td>8,219,140</td>
<td>8,701,512</td>
<td>7,039,346</td>
</tr>
<tr>
<td>Intangible assets</td>
<td>12</td>
<td>99,879</td>
<td>88,986</td>
<td>85,542</td>
<td>76,213</td>
</tr>
<tr>
<td>Derivative financial instruments, net of current portion</td>
<td>21</td>
<td>50,950</td>
<td>459,287</td>
<td>43,637</td>
<td>393,360</td>
</tr>
<tr>
<td>Long-term advance payments</td>
<td>20</td>
<td>141,887</td>
<td>193,381</td>
<td>121,520</td>
<td>165,623</td>
</tr>
<tr>
<td>Other non-current assets</td>
<td>9</td>
<td>3,188,914</td>
<td>2,281,762</td>
<td>2,731,170</td>
<td>1,954,331</td>
</tr>
<tr>
<td><strong>Total non-current assets</strong></td>
<td></td>
<td><strong>14,262,027</strong></td>
<td><strong>11,746,310</strong></td>
<td><strong>12,214,824</strong></td>
<td><strong>10,060,218</strong></td>
</tr>
<tr>
<td><strong>Total assets</strong></td>
<td></td>
<td><strong>23,014,897</strong></td>
<td><strong>22,030,903</strong></td>
<td><strong>19,711,285</strong></td>
<td><strong>18,868,536</strong></td>
</tr>
</tbody>
</table>
## Liabilities:

<table>
<thead>
<tr>
<th>Note</th>
<th>2009</th>
<th>2008</th>
<th>U.S. dollars (Note 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Won</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2009</td>
<td>2008</td>
<td></td>
</tr>
<tr>
<td>Trade accounts payable</td>
<td>17</td>
<td>1,360,142</td>
<td>1,844,304</td>
</tr>
<tr>
<td>Short-term borrowings</td>
<td>13,17,20</td>
<td>2,555,986</td>
<td>3,700,599</td>
</tr>
<tr>
<td>Current portion of long-term debt</td>
<td>15,17,20</td>
<td>2,277,369</td>
<td>1,110,018</td>
</tr>
<tr>
<td>Current portion of finance lease liabilities</td>
<td>16,17,33</td>
<td>27,305</td>
<td>15,191</td>
</tr>
<tr>
<td>Income taxes payable</td>
<td></td>
<td>2,551</td>
<td>1,388</td>
</tr>
<tr>
<td>Other accounts payable</td>
<td>9,17,33</td>
<td>182,575</td>
<td>374,109</td>
</tr>
<tr>
<td>Accrued expenses</td>
<td></td>
<td>110,192</td>
<td>75,725</td>
</tr>
<tr>
<td>Current deferred tax liabilities</td>
<td>28</td>
<td>2,964</td>
<td>61</td>
</tr>
<tr>
<td>Current portion of derivative financial instruments</td>
<td>21</td>
<td>12,084</td>
<td>72,673</td>
</tr>
<tr>
<td>Other current liabilities</td>
<td>14</td>
<td>90,465</td>
<td>60,610</td>
</tr>
<tr>
<td><strong>Total current liabilities</strong></td>
<td></td>
<td>6,621,633</td>
<td>7,254,678</td>
</tr>
</tbody>
</table>

| Debentures, net | 15,17 | 8,936,833 | 7,972,577 | 7,654,019 | 6,828,175 |
| Long-term borrowings | 13,15,17,20 | 811,376 | 1,294,097 | 694,909 | 1,108,339 |
| Other non-current accounts payable | 9 | - | 175,525 | - | 150,330 |
| Finance lease liabilities | 16,17,33 | 940,855 | 1,043,562 | 805,803 | 893,767 |
| Retirement and severance benefits | 18 | 33,242 | 36,858 | 28,470 | 31,567 |
| Derivative financial instruments, net of current portion | 21 | 30,088 | 21,843 | 25,769 | 18,708 |
| Non-current deferred tax liabilities | 28 | 458,423 | 123,281 | 392,620 | 105,585 |
| Other non-current liabilities | 17 | 2,912 | 2,937 | 2,494 | 2,515 |
| **Total non-current liabilities** | | 11,213,729 | 10,670,680 | 9,604,084 | 9,138,986 |

| **Total liabilities** | | 17,835,362 | 17,925,358 | 15,275,233 | 15,352,310 |

## Stockholders’ equity

| Common stock of W5,000 par value | 22 | 386,423 | 386,423 | 330,955 | 330,955 |
| Authorized - 200,000,000 shares | 22 | 386,423 | 386,423 | 330,955 | 330,955 |
| Issued - 77,284,510 shares | 22 | 386,423 | 386,423 | 330,955 | 330,955 |
| Capital surplus | 23 | 1,384,870 | 1,384,870 | 1,186,083 | 1,186,083 |
| Capital adjustments | 23 | (102,474) | (102,461) | (87,765) | (87,754) |
| Accumulated other comprehensive income | 24 | 939,255 | 6,646 | 804,432 | 5,692 |
| Retained earnings | 25 | 2,554,798 | 2,401,713 | 2,188,076 | 2,056,966 |
| Minority interest in consolidated subsidiaries | 26 | 16,663 | 28,354 | 14,271 | 24,284 |
| **Total stockholders’ equity** | | 5,179,538 | 4,105,545 | 4,436,052 | 3,516,226 |

| **Total liabilities and stockholders’ equity** | W | 23,014,897 | 22,030,903 | $19,711,285 | 18,868,536 |
**Figure 12. Perspective and Actual Pipeline Routes**

![Perspective and Actual Pipeline Routes](image1)

**Figure 2. Pipeline natural gas and LNG flows across Northeast Asia**

**Figure 13. Example Russia-Northeast Asia Pipeline Proposal**

![Example Russia-Northeast Asia Pipeline Proposal](image2)

**Proposed natural gas pipeline route from Kovykta to China and Korea**
Figure 14. Conversion Tables

<table>
<thead>
<tr>
<th>1 cf (1 ft&lt;sup&gt;3&lt;/sup&gt;) is equal to</th>
<th>1 cm (1 m&lt;sup&gt;3&lt;/sup&gt;) is equal to</th>
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</thead>
<tbody>
<tr>
<td>0.0283 m&lt;sup&gt;3&lt;/sup&gt;</td>
<td>35.31 ft&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
<tr>
<td>1,000 Btu</td>
<td>35,314.67 Btu</td>
</tr>
<tr>
<td>1 MBtu</td>
<td>35.31 MBtu</td>
</tr>
<tr>
<td>0.000172 boe</td>
<td>0.00609 boe</td>
</tr>
<tr>
<td>1,055 kJ</td>
<td>37,257 kJ</td>
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<th>1 Mcf (1,000 ft&lt;sup&gt;3&lt;/sup&gt;; 1x10&lt;sup&gt;3&lt;/sup&gt; ft&lt;sup&gt;3&lt;/sup&gt;) is equal to</th>
<th>1 Mcm (1,000 m&lt;sup&gt;3&lt;/sup&gt;; 1x10&lt;sup&gt;3&lt;/sup&gt; m&lt;sup&gt;3&lt;/sup&gt;) is equal to</th>
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<tbody>
<tr>
<td>28.32 m&lt;sup&gt;3&lt;/sup&gt;</td>
<td>35,314.67 ft&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
<tr>
<td>1,000,000 Btu</td>
<td>35,314.666 Btu</td>
</tr>
<tr>
<td>1,000 MBtu</td>
<td>35,314.67 MBtu</td>
</tr>
<tr>
<td>1 billion Btu (1x10&lt;sup&gt;9&lt;/sup&gt;)</td>
<td>35,31 billion Btu (1x10&lt;sup&gt;9&lt;/sup&gt;)</td>
</tr>
<tr>
<td>10,000 therm</td>
<td>353 M therm</td>
</tr>
<tr>
<td>172.41 boe</td>
<td>6,088.74 boe</td>
</tr>
<tr>
<td>1.06 TJ (1x10&lt;sup&gt;12&lt;/sup&gt;)</td>
<td>37.26 TJ (1x10&lt;sup&gt;12&lt;/sup&gt;)</td>
</tr>
<tr>
<td>20.53 ton LNG</td>
<td>725.15 ton LNG</td>
</tr>
</tbody>
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<tr>
<th>1 MMcf (1 million ft&lt;sup&gt;3&lt;/sup&gt;; 1x10&lt;sup&gt;6&lt;/sup&gt; ft&lt;sup&gt;3&lt;/sup&gt;) is equal to</th>
<th>1 MMcm (1 million m&lt;sup&gt;3&lt;/sup&gt;; 1x10&lt;sup&gt;6&lt;/sup&gt; m&lt;sup&gt;3&lt;/sup&gt;) is equal to</th>
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<tr>
<td>28.320.6 m&lt;sup&gt;3&lt;/sup&gt;</td>
<td>35,314.67 Mcf</td>
</tr>
<tr>
<td>1,000,000 MBtu</td>
<td>35,314.67 MMBtu</td>
</tr>
<tr>
<td>1 billion Btu (1x10&lt;sup&gt;9&lt;/sup&gt;)</td>
<td>35,31 billion Btu (1x10&lt;sup&gt;9&lt;/sup&gt;)</td>
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<td>35.31 bcf</td>
</tr>
<tr>
<td>0.0283 bcm</td>
<td>0.033 bcf</td>
</tr>
<tr>
<td>1 trillion Btu (1x10&lt;sup&gt;12&lt;/sup&gt;)</td>
<td>35,315 trillion Btu (1x10&lt;sup&gt;12&lt;/sup&gt;)</td>
</tr>
<tr>
<td>10,000 M therm</td>
<td>353.147 M therm</td>
</tr>
<tr>
<td>10 MM therm</td>
<td>353.15 MM therm</td>
</tr>
<tr>
<td>172.41 Mboe</td>
<td>6,088.74 Mboe</td>
</tr>
<tr>
<td>1.06 PJ (1 x 10&lt;sup&gt;15&lt;/sup&gt;)</td>
<td>37.26 PJ (1 x 10&lt;sup&gt;15&lt;/sup&gt;)</td>
</tr>
<tr>
<td>0.021 MM ton (MT; million) LNG</td>
<td>0.725 MM ton (MT; million) LNG</td>
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The initial estimation of NPV had several assumptions built into it for the sake of simplicity. In order to calculate more realistic return on investment it was necessary to run a probabilistic risk simulation that varied several of the input factors used to calculate NPV. Essentially, this accounts for the inherent risks that will come about during the life of the project. For example, it is unlikely that South Korea’s 10 year bond, or borrowing cost, will remain at exactly 4.52%. Thus this simulation models how the NPV would change if South Korea’s borrowing cost varied within a given range. The inputs that are subject to variation are:

a. Initial Outlay or Cost of Construction
   - This variable was given a normal distribution with a mean value of $10,631,010,000.00 USD with a standard deviation of $1,500,000,000.00.

b. Cost of Capital
   - As this variable was determined by the interest rate on 10 year South Korean and Russian Federation bonds it was altered by placing probability distributions on the interest rates of those securities. Specifically, a normal distribution was used where the spot rate was used as the mean and the standard deviation was defined as 1% for South Korea and 1.5% for Russia, based on the larger historical volatility of Russian bonds over the last 15 years.
c. Payment

- As this variable is determined by the anticipated output of the pipeline and the expected price of natural gas, it was altered by placing probability distributions on those two variables. For anticipated output, a normal distribution was used with the mean value being 7.5 billion with a standard deviation of 2 billion. For the price, a normal distribution was also used with the current spot rate of $4.37 USD being used as the mean with a $1.00 standard deviation.

Once all inputs likely to fluctuate during the life of the project were given a probability function, the simulation ran 5000 iterations to compile the probability curve seen above. From this curve, it can be seen that, even with all of the inputs fluctuating within a reasonable range, there is only a 5% chance of this project returning an NPV below zero.

The graph above simply shows the regression coefficients for the input variables likely to change. In other terms, this graph shows which input variables, when fluctuating, have the most effect on the final NPV of the project. From this graph, we can see that the most important factor for predicting the NPV of this project is the anticipated output of the pipeline once installed. This is both positive and negative in nature. It is positive, because even if the South Korean or Russian government’s borrowing costs increase significantly, it will have little effect on the profitability of the project. However, this also means that if North Korea does disrupt the flow of natural gas during the life of the project, its profitability will be severely affected.
Works Consulted


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