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### Coal Policies of South Korea and Japan in Comparative Perspective

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#### ABSTRACT

Northeast Asian countries compete against one another in order to procure natural resources from abroad. Moreover, competition surrounding energyrelated technologies is getting overheated in this region. It would be worth paying attention to energy competition between South Korea and Japan, so we can better understand energy security in Northeast Asia by comparing South Korea's and Japan's energy strategies. This paper examines how important coal is in the two countries' economies and why coal has become so important . It also analyzes the similarities and differences of their coal policies, especially focusing on policy trends and prospects related to Clean Coal Technology. This paper will warn of another hot competition among the countries in this region and suggest multilateral cooperation.

#### INTRODUCTION

Due to the overheated competition for procuring energy sources among neighboring countries, Northeast Asia is entrapped in energy insecurity. Most of Northeast Asian countries, including South Korea, Japan, and China, are huge energy consumers in the world. For example, Japan is the fourth largest oil consumer following the United States, European Union and China, and South Korea ranked tenth in 2009 (CIA<sup>1</sup>). Some scholars have paid attention to competitions among Northeast Asian countries in the global oil market. Kent Calder (2007)<sup>2</sup>, for example, illuminates the bilateral energy rivalry between China and Japan. As Calder explains, both China and Japan heavily depend on oil, most of which is from the Middle East. The two economic giants in Northeast Asia are competing against each other in order to secure oil. This kind of competition among neighbors induces major oil producing countries to request an "Asian Premium" on Northeast Asian oil consumers, which increases the price of imported oil.

Competitive dynamics between China and Japan have already become a popular topic in the field of International Relations, but it can be argued that competition between South Korea and Japan should receive more attention for the following reasons. First of all, both South Korea and Japan have two of the world's largest economies. Recently, China has attracted more attention than any other country, but it is not the only actor in the international arena. As a single country, Japan's Gross Domestic Product (GDP) had been the world's second largest next to the U.S. before it was overtaken by China in 2010, and South Korea had the thirteenth largest GDP in 2010 (CIA). The competition between these two neighboring countries cannot be neglected and their confrontation suggests significant implications for regional economic cooperation. Secondly, comparing policies of South Korea and Japan is analytically attractive because the two countries have many things in common. Both South Korea and Japan have a free market economy, both are export-oriented economies, and the structures of their energy security resemble each other. This paper will explore how similar or different energy strategies of the two countries are and what is needed to overcome their cognate problems.

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The primary purpose of this paper is to show the dynamics of energy competition in Northeast Asia, particularly in the Clean Coal Technology (CCT) area, by comparing the related policy trends and prospects of South Korea and Japan. Coal is less prized in advanced industrial countries due to its environmentally negative aspects, though many developing countries still find it is an attractive energy source for its cost-efficiency. However, this study reveals that coal still plays a significant role in the South Korean and the Japanese economy, both of which are highly advanced and industrialized.

In the first section, I will provide an overview of how much important coal is to South Korea and Japan. This part will outline the two countries' energy consumption and the demand-and-supply structure of coal in the two countries. By explaining the energy structure of South Korea and Japan, it will be clear that South Korea and Japan are becoming more dependent on coal. In the second section, I will analyze the reasons why South Korea and Japan rely on coal. First, both South Korea and Japan depend on oil from the Middle East, which is one axis of their energy security structure. Both South Korea and Japan selected coal as their reliable energy source to escape from oil and Middle East dependency. Second, coal is very important in both South Korea's and Japan's heavy industry, especially the steel industry. Steel, one of the most important export goods of the two countries, requires coal as an input.

According to the World Steel Association<sup>3</sup>, Japan is the second and South Korea is the sixth largest steel producing country in the world. They have to compete not only to sell their products in the global steel market, but also to secure coal supplies in the global coal market. However, the growing importance of coal in their economies and its increasing environmental threat put South Korea and Japan in another energy insecurity trap. South Korea and Japan have to deal with air pollution while they need to keep their coal dependency. In the third section, I will compare the two countries' coal policies, especially focusing on the policy trends of CCT. Both South Korea and Japan perceive that developing CCT is the best way to solve their problems, and they are rigorously developing CCT. In the last section, I will analyze implications of the CCT competition between South Korea and Japan for Northeast Asian energy security.

#### INCREASING IMPORTANCE OF COAL IN South Korea and Japan

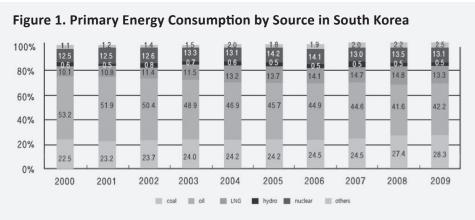
Coal is important, especially to developing countries, because it is inexpensive compared to oil and natural gas. The demand for coal in the world is steadily going up, particularly in Asia where a number of developing countries are located. According to the World Coal Association's data,<sup>4</sup> the total proven coal reserve in the world is estimated to be more than 847 billion tons. In other words, we can use coal for the next 118 years at current rates of production. Compared to oil or natural gas, coal reserve still seems to be ample. In addition, coal reserve is more widely distributed throughout the world; Table 1 shows how much coal the top ten countries produced in 2010. Interestingly, most of

the major coal producing countries are located in the Asian-Pacific region. Based on the above reasons, Asian countries should recognize coal is one of the most stable energy sources in the long run. Coal is significant to advanced industrial economies, South Korea and Japan in particular. In this section, I will analyze how much importance coal has as a strategic resource in these two countries.

Table 1. Top Ten Hard Coal Producers (2010e)									
China	USA India Australia South Africa								
3162	932	538	353	255					
Russia	Indonesia	Kazakhstan	Poland	Colombia					
248	173	105	77	74					
(Unit: Million Ton) Source: The World Coal Association's Webpage									

#### South Korea's Growing Coal Dependency

South Korea was the world's third largest coal importer in 2010 (Ibid.) and its consumption ranked the eighth largest in 2009 (Europe's Energy Portal <sup>5</sup>). In South Korea, coal consumption has been gradually increasing as Figure 1 and Table 2 prove. Figure 1 shows that coal has been the second largest primary energy source in South Korea next to crude oil for the last decade; coal currently represents almost 30% of South Korea's primary energy consumption. Table 2 shows the South Korean government also estimated that the total amount of coal demand would continue to increase in South Korea in the near future.



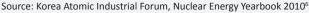
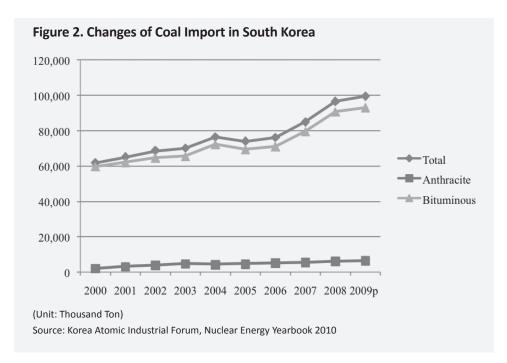


Table 2. Estimated Coal Demand in South Korea											
·01-·06 ·01-·11 ·01-·20											
2001 2006 2011 2015 2020 Average Annual Increasing Rate											
Coal	45.7	52.4	65.5	67.1	72.0	3.1	3.7	2.4			
Anthracite	3.7	2.8	2.6	2.2	2.3	-5.6	-3.5	-2.5			
Bituminous 42.0 50.6 62.9 64.8 69.7 3.8 4.1 2.7											
· · · · · · · · · · · · · · · · · · ·	(Unit: Million Ton, %) Source: The Government of the Republic of Korea, National Basic Plan for Energy, the 2nd term 2002-2011 <sup>7</sup>										

Table 2 shows that coal is categorized into two different types, anthracite coal and bituminous coal, and these two types of coals show dissimilar trends in South Korea.<sup>8</sup> South Korea developed their domestic mining industries during the early period of its industrialization, and most of its domestic coal is anthracite coal. Because of its lower calorific content, anthracite coal was consumed mainly for domestic heating fuel. However, since South Korea made great efforts to raise their energy efficiency, anthracite coal as a domestic fuel already lost its status in South Korea. Currently, anthracite coal has been in oversupply in South Korea. From 1988 to 2001, consumption of anthracite coal decreases at an average annual rate of 13%; in 2001, the accumulated stock of anthracite coal was already 10.6 million tons (MCIE and KEEI 2002,<sup>9</sup> 231). Table 2 also shows the South Korean government expects the demand for anthracite coal will continue to decrease. Instead, South Korea heavily depends on bituminous coal, most of which must be imported. Table 3 shows how the total amount of imported coal has actually changed in South Korea. As Figure 2 indicates, the rapid increase of coal import in South Korea coincides with the growing import of bituminous coal, and the increase within the past five years has been quite sharp. Compared to the amount in 2000, the total amount of imported coal in South Korea is almost 1.6 times more.

Table 3. The Amounts of Coal Import in South Korea											
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009p
Thousand ton	Total	61,638	64,966	68,519	69,958	76,354	73,897	76,001	84,799	96,425	99,420
	Anthracite	2,038	3,110	3,879	4,640	4,251	4,567	5,113	5,444	5,995	6,468
	Bituminous	59,600	61,856	64,640	65,318	72,103	69,330	70,888	79,355	90,470	92,952
Million Dollar	Total	2,105	2,275	2,475	2,552	4,438	5,443	5,318	6,446	12,810	9,995
	Anthracite	72	118	148	177	233	429	407	448	991	672
	Bituminous	2,033	2,157	2,327	2,375	4,205	5,014	4,911	5,998	11,819	9,323
	p means potential. Source: Korea Atomic Industrial Forum, Nuclear Energy Yearbook 2010										



In 2001, the South Korean Ministry of Commerce, Industry and Energy (MCIE) identified bituminous coal as a strategic resource along with oil, natural gas, and uranium because it has played a significant role in the South Korean economy, and its supply heavily depends on import (Kim 2005<sup>10</sup>, 108). Table 4 shows how bituminous coal has been consumed in South Korea. From this data, we can find out several important points for further analysis. First, during the period of its early industrialization, in other words before the 1980s, bituminous coal was used only for industrial purposes in South Korea. Since the 1980s, bituminous coal began to be used as an input source for generating electricity. Second, since the 1990s, the bituminous coal demand for generating electricity rapidly increased. Compared to 5.723 million tons in 1990, almost three times larger an amount of bituminous coal, 14.229 million tons, was used to generate electricity in 1995. Increase in the demand of coal for electricity generation expanded the general consumption of bituminous coal in South Korea. Table 5 gives you more details of how bituminous coal was consumed in South Korea for the last decade. Even though there were some ups and downs in industrial usage, consumption for electricity generation continuously gets larger, which drives the total consumption of bituminous coal up. Figure 3 proves coal currently occupies the biggest share of electricity generation in South Korea. Third, the consumption levels in the industrial part continued to fall, but stably maintain their significant portion. Heavy industry is still a pillar of the South Korean economy, and bituminous coal is an important input source for that.

Table 4. Changes of Bituminous Coal Consumption by Purpose in South Korea									
	1960	1985	1990	1995	2000	2001			
Electricity	-	5.14	5.723	14.229	33.305	36.602			
(percent)	-	34.9	26.2	37.4	55.2	57.5			
Industry	5.032	9.557	16.153	23.86	27.024	27.084			
(percent)	100	65.1	73.8	62.6	44.8	42.5			
Steel	3.987	6.959	11.735	16.305	19.415	19.313			
Cement	1.045	2.476	3.534	5.59	5.308	5.475			
Miscellaneous	-	0.122	0.882	1.965	2.301	2.296			
Total	5.032	14.697	21.876	38.089	60.329	63.686			

(Unit: Million Ton, %)

Source: Ministry of Commerce, Industry, and Energy, and Korea Energy Economics Institute, 2010 Energy Vision: Direction of Energy Policy and Strategy for Development

### Table 5. Recent Changes in Bituminous Coal Consumption by Purpose inSouth Korea

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	Ste	Steel		Electricity		Cement		Others		al	
2000	19,415	5.3	33,305	17.7	5,308	4.7	2,301	-1.2	60,329	11.4	
2001	19,315	-0.5	36,602	9.9	5,475	3.1	2,296	-0.2	63,686	5.6	
2002	20,097	4.1	40,143	9.7	5,669	3.5	2,355	2.6	68,264	7.2	
2003	20,509	2.0	41,630	3.7	6,060	6.9	2,339	-0.7	70,539	3.3	
2004	20,839	1.6	45,512	9.3	5,309	-12.4	2,318	-0.9	73,978	4.9	
2005	20,810	-0.1	47,851	5.1	4,807	-9.5	2,320	0.1	75,788	2.4	
2006	20,731	-0.4	50,198	4.9	4,738	-1.4	2,328	0.3	77,998	2.9	
2007	21,519	3.8	55,487	10.5	5,051	6.6	2,374	2.0	84,430	8.2	
2008	23,568	9.5	62,791	13.2	5,236	3.7	2,388	0.6	93,983	11.3	
2009p	20,734	-12.0	71,091	13.2	4,463	-14.8	2,314	-3.1	98,602	4.9	

(Unit: Thousand Ton, %)

Percentage means the change compared to the previous year.

p means potential.

Source: Korea Atomic Industrial Forum, Nuclear Energy Yearbook 2010

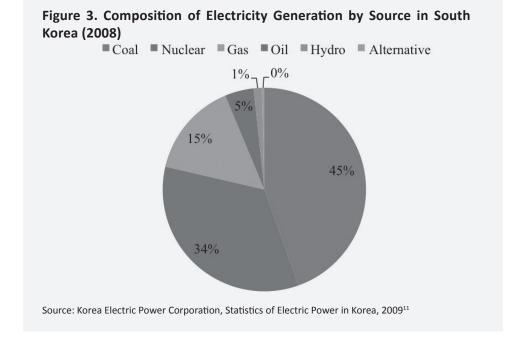
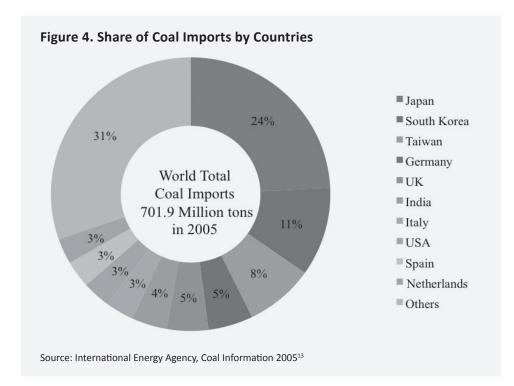


Table 6 also shows how the South Korean government estimated the current and the future demand for bituminous coal. In brief, two things can be concluded; first, that coal demand for electricity generation increased dramatically in South Korea since the mid-1980s and the trend is likely to continue in the near future due to expanding demand. Second, the demand for bituminous coal for industrial purposes, which has remained high since the 1980s, will still keep its current level or climb slightly as long as the South Korean economy grows.

Table 6. Estimated Demand for Bituminous Coal in South Korea										
	'00 - '10	'10 - '20								
	2000	Average / Increasin								
Steel	19.415	20.302	20.444	20.512	20.483	0.5	0.0			
Cement	5.308	5.728	5.879	6.009	6.115	1.0	0.4			
Miscellaneous Industries	2.301	2.541	2.754	2.803	2.894	1.8	0.5			
Electricity	33.305	44.816	60.183	56.812	61.876	6.1	0.3			
Total	60.329	73.387	89.26	86.135	91.368	4.0	0.2			
(Unit: Million Ton, %) Source: MCIE and KEEI, 2010 Energy Vision: Direction of Energy Policy and Strategy for Development										

#### Japan's Growing Coal Dependency

Japan is the biggest coal importer in the world and it ranked the fourth largest coal consumer in 2010; Japan imported 187 million tons of coal in 2010 (World Coal Association). Japan's import share occupies 24.3% of the whole amount of imported coal in 2004 (Figure 4). 99% of coal domestically consumed in Japan is imported from abroad; 62.8% of the whole amount was imported from Australia; 19.1% from Indonesia, 5.7% from China, 5.6% from Canada, 5.1% from Russia, and 1% from the U.S. (METI 2010<sup>12</sup>)



As Figure 5 shows, the coal consumption in Japan has continued to increase for the last two decades. According to Energy White Paper 2006<sup>14</sup>, the average annual increase from 1980 to 2003 was 2.4%. In 1973, the total demand for coal was 78.98 million tons. The demand exceeded 100 million tons in 1984, and it reached 184.84 million tons in 2004. Japan also used to produce its domestic coal during the period of its early industrialization as South Korea did. Japanese domestic coal production reached a climax in 1961 with 5.541 million tons, but since then, domestic production has continuously declined because of increasing oil consumption, inflow of cheaper imported coal and exhaustion of its domestic reserves (METI 2010). In 2001, the Ikedo coal mine (located in Nagasaki Prefecture) was closed, and the only remaining coal mine, the Taiheiyou mine (located in Hokkaido), was finally shut down in 2002. On the other hand, the demand for imported coal has been increasing in order to satisfy growing domestic demand for coal. Figure 6 shows you how the breakdown of imported and domestic coal has changed in Japan for the last five decades.

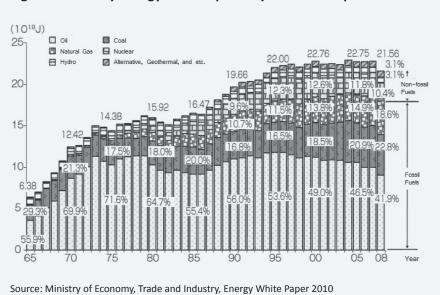
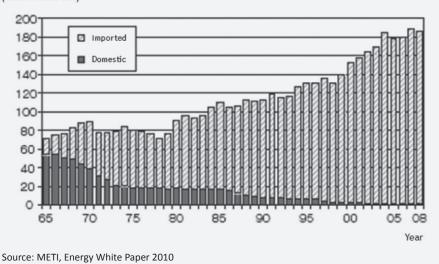


Figure 5. Primary Energy Consumption by Source in Japan

#### Figure 6. Changes Coal Supply in Japan: Imported vs. Domestic



(Unit: Million ton)

Unlike South Korea, the Japanese government categorized coal into three different types: anthracite coal, cocking coal and non-cocking coal.<sup>15</sup> Among those, anthracite coal is not critical as an energy resource in Japan for the same reason as in South Korea. However, cocking and non-cocking coal play a significant role in the Japanese economy. Among the total demand for coal, the largest portion is currently occupied by the demand for generating electricity; 83.78 million tons of coal is used for electricity generation. The second largest demand is for making steel; 64.87 million tons of coal is consumed by Japan's steel industry. These two parts hold 81.1% of the whole demand for coal in Japan (Ibid.).

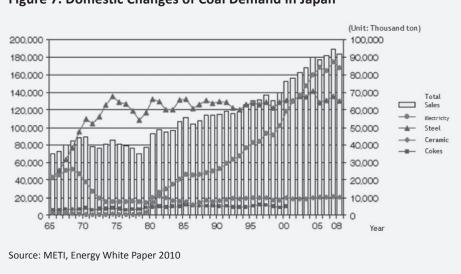
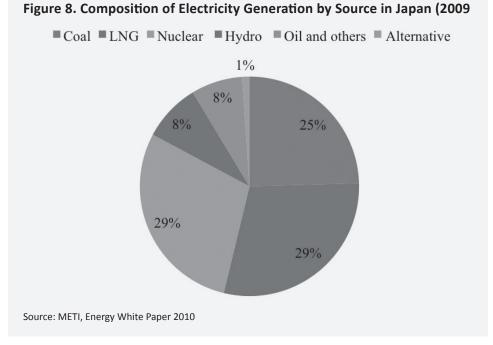


Figure 7. Domestic Changes of Coal Demand in Japan

Figure 7 above shows how the domestic demand for coal has changed in Japan. Generally, the total coal demand fell in 1998, including the demand for noncocking coal for generating electricity, but in 1999 the total demand bounced up again. The coal demand for industrial purposes, which is supplied with cocking coal, maintains a consistent level of consumption. The largest demand for cocking coal is still from the steel industry. The Japanese steel industry is one of the top in the world, and its demand for coal has remained at a stable level for the last two decades. Meanwhile, the demand for electricity generation, which is supported by non-cocking coal, continues to increase. Especially since 1980, the imported non-cocking coal for generating electricity has been sharply increasing. Moreover, in 1999, it rose up again as the Japanese economy recovered from the economic recession caused by the Asian Financial Crisis. In 2001, the coal demand for generating electricity exceeded the demand for making steel. From 1980 to 2003, the coal demand for electricity increased at an average annual rate of 9.2%. In 2006, the Japanese Ministry of Economy, Trade and Industry (METI) reported that the total demand for non-cocking coal is 92.71 million ton, which is almost half of the total demand for coal (METI 2006).



From the Japanese data above, we can make very similar conclusions with the South Korean case. First, imported cocking and non-cocking coal can be regarded as critical strategic resources for the Japanese economy. Anthracite coal is relatively obsolete in contrast to cocking and non-cocking coal. Second, the coal demand for generating electricity has dramatically increased in Japan as well, but the trend started a little earlier than in South Korea, since 1980. Figure 8 shows the current composition of electricity generation by source in Japan. Coal occupies a significant share in electricity generation with 25%. Third, the demand for coal for industrial purposes, especially as an input source for making steel, has maintained its significant level in Japan for the last two decades, just as in South Korea. In the following section, I will analyze the reasons why these trends are commonly observed in South Korea and Japan.

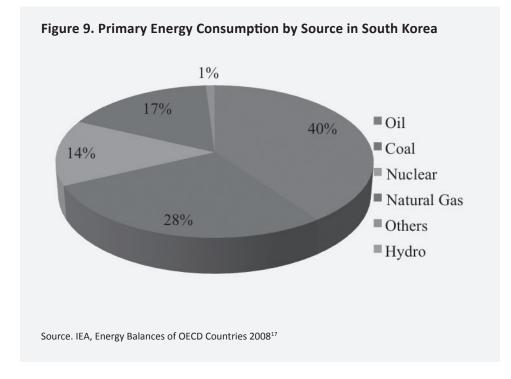
#### RATIONALES AND CONCERNS BEHIND THE Growing Coal Dependency

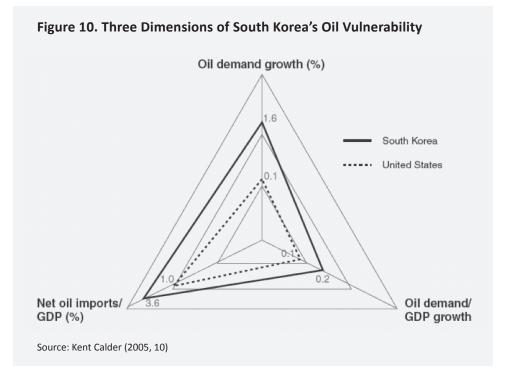
In the previous section, I outlined the common trend of growing coal dependency in South Korea and Japan; first, the coal demand for electricity generation has increased in the two countries and this trend is likely to continue even for the next decade both in South Korea and Japan. Second, coal for industrial purposes has steadily been increasing in demand in the two countries, but coal consumption for industrial purposes has not increased. Therefore, it can be assumed that coal consumption for heavy industry would not largely affect the growing demand for coal in the two countries. Instead, it can be concluded that the total coal demand in South Korea and Japan has been and is likely to be driven by the increasing demand for electricity generation. In this section, I will analyze how the two countries became more dependent on coal than before by analyzing the common energy security problems that South Korea and Japan encounter. In the latter part of the section, I will also clarify the common challenge by increasing coal consumption.

#### **Escape from Oil Dependency**

South Korea and Japan have many things in common especially in terms of their energy security structure. Both of their economics are export-oriented while neither of them has substantial natural resources within their own territories. Stabilizing the import of natural resources is the most urgent priority for the two countries in order to continue their economic development because they are extremely susceptible to any subtle changes in global natural resource markets.

The most vulnerable point both South Korea and Japan have dealt with is their heavy oil dependency. In spite of strenuous efforts to overcome it, oil still made up 40% of South Korean's primary energy source consumption in 2008 (Figure 9). According to Calder (2005<sup>16</sup>, 7), "South Korea confronts some of the most severe energy-security dilemmas in the world, and these dilemmas form an unusual triad combination, intensifying the challenge that they present to the country's economic future." First, South Korea does not have sufficient domestic energy resources to support its rapdily growing and energy-intensive economy. Second, South Korea relies on oil as a fuel source, which is very unusual from a worldwide perspective. Third, most of the oil imported in South Korea comes from the politically unstable Middle East. Figure 10 reveals how serious South Korea's oil vulnerability is compared to the U.S.

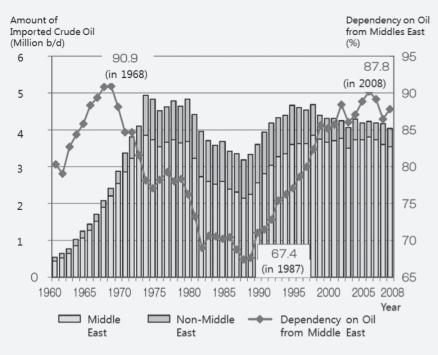




The South Korean government perceives its energy situation in a very similar way to Calder. According to the National Energy Strategy Report for the 2005 Regular Session of the National Assembly,<sup>18</sup> the South Korean government defines its energy security dilemma as follows: first, oil and Middle East dependency is the most serious problem South Korea should fundamentally overcome; and second, the pattern of energy consumption is getting more intensive while the oil and Middle East dependency has not improved remarkably. South Korea has pursued policies to diversify its energy sources and energy suppliers in order to support its growing energy consumption.

The two oil shocks, in 1973 and 1979, sparked South Korean efforts to escape from oil and Middle East dependency. However, as South Korea's economy rapidly grew, the demand for energy has also increased quickly. In particular, the increase in demand for generating electricity was remarkable. The South Korean government decided to use coal as a substitute energy source to fulfill the rising energy demand after the two oil shocks (Kim 2005, 172). Consequently, the demand for coal rose sharply in the early 1980s, as already shown in the previous section. The South Korean government analyzed that the average annual increase to the demand for bituminous coal would be 1.9%. In addition, the bituminous coal demand for electricity generation would increase an average of 2.8% per year. It is projected that bituminous coal demand for electricity will reach 61.9 million tons in 2020, almost two times larger than the 33.3 million tons needed in 2000 (MCIE and KEEI 2002, 243). Japan encounters situations very similar to those in South Korea. Japan's oil dependency, especially its heavy dependency on the Middle East, is as serious as in South Korea. Its dependency rate on oil from the Middle East peaked in 1968 reaching 90.9% (Figure 11). The two oil shocks made Japan recognize that it was urgently required to escape from oil and Middle East dependency. The Japanese government encouraged developing new energy technology, including nuclear energy, and it tried to increase the import of natural gas instead. In May 1980, Japan promulgated the "Law Related to Development and Induction of Alternative Energy for Oil (Law No. 71, May 30, 1980, Sekiyu Daitai Enerugi no Kaihatsu oyobi Donyu ni Kansuru Horitsu)." Based on this law, Japan started to substitute coal for oil, particularly for electricity generation. Especially since 1999, the coal demand for generating electricity remarkably rose as seen in Figure 7. One of the main reasons for this change was the privatization of the electricity market in Japan. Since Japan privatized their electricity market in the early 2000s, Japanese utilities companies have positively promoted establishing thermoelectric power plants and using coal in order to lessen their cost to generate electricity.





Source: METI, Energy White Paper 2010

Thanks to these efforts, Japan's oil dependency gradually fell until the late 1980s, but it bounced up again as shown in Figure 11. Its heavy dependency on Middle Eastern oil recovered its threatening level; in 2008, almost 88% of Japan's imported oil was from the Middle East. Japan's oil dependency still remains higher compared to other major developed countries. (Figure 12) This situation constrains Japan politically, since they have to rely on "the volatile Middle East" (Calder 2005, 7) and limits Japan's energy policy options. Coal is unlikely to be abandoned in Japan in the near future because it is so significant as an input source for electricity generation, which can contribute to lessening oil dependency.

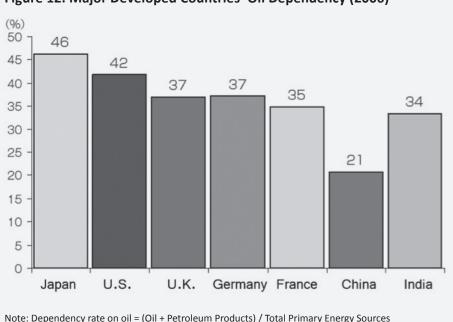


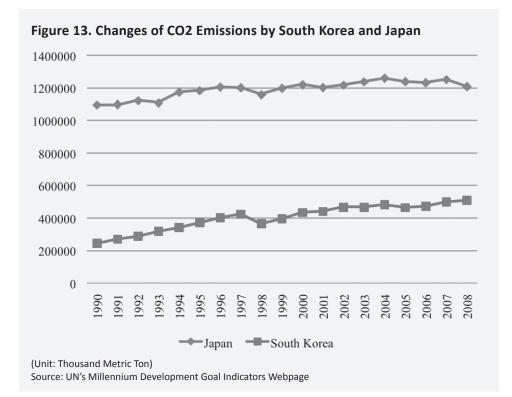
Figure 12. Major Developed Countries' Oil Dependency (2006)

Note: Dependency rate on oil = (Oil + Petroleum Products) / Total Primary Energy Sources Consumed \* 100 Source: METI, Energy White Paper 2009<sup>19</sup>

#### **Entrapped in Coal Dependency**

To make a long story short, both South Korea and Japan selected coal as a substitute for oil, to help them escape from their heavy dependency on Middle Eastern oil. Increasing coal consumption was an economically rational choice in order to support their "bike economies". However, their coal dependency meant the two countries had to face environmental concerns as well. Bituminous coal produces a substantial amount of carbon dioxide (CO2), which causes global warming when it burns. It also makes sulfur oxides (SOx), nitrogen oxides (NOx), and a lot of coal dust which severely pollutes air. As long as the conventional way to burn coal is not improved, air pollution will be another serious challenge for both South Korea and Japan to overcome.

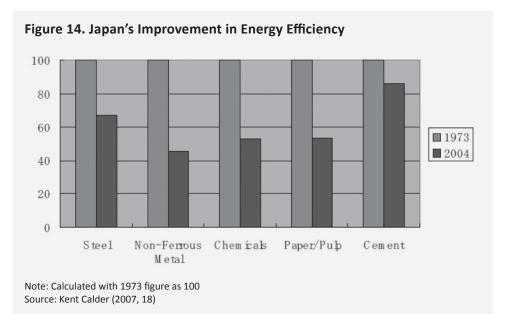
South Korea and Japan are already two of the largest CO2 producers in the world. Figure 13 shows how much CO2 has been produced by South Korea and Japan during the last two decades. Japan's CO2 emissions reached 1,208,163 thousand metric tons in 2008, ranking Japan fifth, and contributing 4.1% to the global total. In the same year, South Korea was the tenth largest, producing 509,170 thousand metric tons and occupying 1.69% of the world's total (UN's Millennium Development Goal Indicators<sup>20</sup>).



Furthermore, the two countries are engaged in major climate change treaties, which require their commitment. South Korea signed the United Nations Framework Convention on Climate Change (UNFCCC) in December 1993. UNFCCC, as an international environmental treaty, was opened for signing in 1992, and it took effect in 1994. The treaty aims at stabilizing emission of greenhouse gas to stop global warming and 190 countries joined this treaty. Even though the treaty originally did not set any mandatory limit on greenhouse gas emissions and it is not legally binding for individual countries, South Korea has the pressure to abide by the general regulations of the treaty. The Kyoto Protocol set updated mandatory emission limits, but the number of joining countries is much smaller than UNFCCC's; only 38 developed countries signed it. South Korea was not a signatory, and is not required to adhere to the limits of the protocol, because it was not categorized as a developed country at that time. However, many developed countries are encouraging countries like South Korea to voluntarily keep to the limits set by the Protocol.

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Japan also has pressure to follow international climate change treaties. As a key member state of the Kyoto Protocol, Japan is required to reduce its 1990 level of greenhouse gas emissions by 6% between 2008 to 2012. This may be a difficult goal for Japan to achieve , since Japan's energy efficiency is very high already. Figure 14 proves that Japan greatly improved its energy efficiency from 1973 to 2004 in every category; its energy efficiency in industrial parts is the top in the world (Kim 2005, 513). Given this, it will be harder for Japan to meet the requirements to improve its efficiency set by international treaties.



In sum, South Korea and Japan became more dependent on coal because they decided to substitute coal for oil in order to supply sufficient electricity to meet the needs of their growing economy. However, it seems certain that the two countries fell into another energy security dilemma by increasing their coal consumption, since they are required to keep their greenhouse gas emissions below the required level set by international treaties, while significantly depending on coal for their economic development.

#### POLICY COMPARISON

When coal burns, it produces a lot of harmful pollutants into the atmosphere, such as coal dust and sulfurous acid gas. Because coal includes veinstones, which decreases thermal efficiency, burning coal produces a lot of CO2 as well. Coal-fired plants are regarded as one of the main culprits of CO2 emission. South Korea and Japan are entrapped in another energy security dilemma by being more coal-dependent, thereby increasing environmental concerns. Therefore, it becomes necessary for the two countries to develop CCT to mitigate air pollution by coal combustion.<sup>21</sup> In this section, South Korea's and Japan's policy trends regarding CCT will be briefly compared.

#### South Korea's Policy Trends regarding Clean Coal Technology

UNFCCC took effect in March 1994, which conclusively affected South Korea's energy policies. The South Korean government clarifies that it is necessary to completely execute "the Ten-Year Energy Technology Development Plan 1997 - 2006"; which is the first comprehensive guideline the South Korean government announced in order to rightly react to the pressure by UNFCCC. This plan includes strategies for improving energy efficiency, finding substitute energy sources and developing new technologies, including clean technologies related to the use of fossil fuels, such as oil and coal.

Even before the above plan, the South Korean government also proclaimed "the Five-Year Clean Technology Development Plan 1994 - 1998" and has promoted clean technology, including CCT. Compared with other industrialized countries such as Japan and the U.S., however, South Korea's CCT remained at a relatively lower level. One main reason is their volume of R&D investment was smaller. Even though values of CCT were appreciated, the South Korean government's subsidy for CCT used to be quite conservative. South Korean companies were also hesitant about being on the cutting edge in this industry. South Korea still saw itself as a chaser rather than a pioneer, while being averse to taking risks in less explored fields.

Since 2006, attention on CCT drastically rose; the South Korean government launched the task force for Integrated Gasification Combined Cycle (IGCC) on December 16, 2006. Since then, South Korea started a large-scale project that has aimed to develop Korean original design technology and construct a 300MW-IGCC demonstration plant. For this project, Korea Electric Power Corporation (KEPCO), five regional power generation companies, Doosan Heavy Industries & Construction, and other research institutes built up a consortium. For the first three years, until November 2009, they achieved the first goal, namely, development of key technologies and design of a demonstration plant. South Korea is trying to move forward to the second stage of construction of the demonstration plant, which is supposed to be finished by 2012 (MKE and KEMC 2010<sup>22</sup>, 538).

South Korea is also trying to export its CCT to Asian developing countries. In March 2010, for example, South Korea's National Fusion Research Institute (NFRI, Kookga Haek Yoonghap Yeonkuso) announced that it would promote commercialization of IGCC, which is based on plasma technology, in India (Lee 2011<sup>23</sup>). One year later, in March 2011, South Korea signed a memorandum of understanding (MOU) with Mongolia regarding CCT development. Based on the bilateral MOU, South Korea will transfer its CCT, including its upgrading coal quality technology to Mongolia, and South Korea will get a more secure supply of coal from Mongolia. Based on this MOU, a joint company will be established, and Korea Gas Corp., Korea Coal Corp., POSCO and SK Innovation Ltd. seem to be interested in this project (Ahn 2011<sup>24</sup>). Meanwhile, in August 2011, KEPCO clarified that it would invest 2.8 trillion won to clean energy development, which includes IGCC and Carbon Capture and Storage (CCS)-related projects.<sup>25</sup>

The South Korean government's policy regarding CCT development can be summarized as follows: first, the South Korean government recognized that South Korea is behind other developed countries in the field of CCT. By concentrating on some key technologies, which can make visible results sooner, the South Korean government aims to develop CCT more efficiently. Second, the South Korean government understands that it is critical to encourage technology exchange by fostering relationships with countries with more advanced CCT than South Korea, such as the U.S., China, Japan, Canada and Australia. Since 1984, the Korean Institute of Energy Research (KIER) has held technology workshops with Pittsburgh's Energy Technology Center (PETC), which is under the U.S. Department of Energy. Since 1996, KIER has successfully co-sponsored its biennial technology workshops with Federal Energy Technology Center (FETC), and there have already been 13 workshops in either South Korea or the U.S.<sup>26</sup>

In addition, South Korea's MCIE helped improve technology exchange with China, which is the second largest coal exporter to South Korea and seriously affects environmental impacts in South Korea. The technology exchange workshop between South Korea and China also started in 1996, and it has been held every other year. South Korean engineers, governmental officials, and civil activists have participated in those meetings. South Korea is trying to improve its CCT by efficiently spending its energy budget and by closely cooperating with other leading countries. Interestingly, governmental reports reveal that South Korea may not be cooperating with Japan as much as with the U.S. and China (MKE 2005).<sup>27</sup>

#### Japan's Policy Trends regarding Clean Coal Technology

Compared to South Korea, Japan's CCT is more advanced. New Energy and Industrial Technology Development Organization (NEDO), as the center of Japan's CCT development, has been trying to develop several critical CCT, such as coal combustion technology, gasification technology and pyrolysis technology. Japan's policy regarding CCT is called Clean – Coal – Cycle (C3) Initiative, announced in June 2004. According to the Energy White Paper 2006, the C3 Initiative includes the following strategies: first, Japan should intensively invest in developing CCT, completely execute the technology in ordinary lives, and extend the technology domestically and internationally. Second, Japan should stabilize its supply of coal, thereby ensuring a reasonable price because the most attractive factor of coal is its affordable price compared to other conventional energy sources. Third, Japan should establish infrastructures to support executing this C3 Initiative, such as an international network with coalproducing countries and seek publicity regarding its policies.

Japan's C3 Initiative implies three things. First, the Japanese government regards CCT as one of the key technologies Japan should concentrate on, and it has set aside a huge amount of its budget in order to develop CCT. In 2005, for instance, the Japanese government spent 11.719 billion yen on developing CCT, 3.617 billion

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yen for developing other related technologies, and 1.083 billion yen for extending its technological knowledge by hosting conferences or educating engineers (METI 2006). The total budget related to science and technology of METI in 2005 was 59.07 billion yen, and the budget spent for CCT in 2005 was almost 27% of the total budget, or 16.419 billion yen out of 59.07 billion yen (KIIT 2005<sup>28</sup>, 4). In 2009, Japan spent more than 7 billion yen for CCT for the main purpose of developing IGCC and Carbon CCS (METI 2010). The amount of money spent for CCT by the Japanese government is enormously beyond the amount spent by the South Korean government.

Second, Japan is trying to extend CCT to other developing countries, especially to Asian developing countries. By promoting technology seminars or accepting engineers from abroad, Japan is trying to spread its advanced CCT in Asia. The Japanese government perceives that stable economic growth and environmental security of Asian developing countries is conducive to Japan's economical success as well. In addition, Japan understands that it can increase its influence on Asian developing countries by providing substantial CCT.

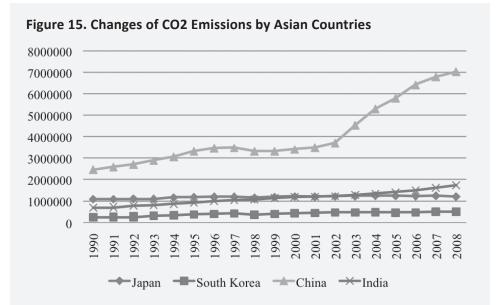
Third, the Japanese government recognizes that it is necessary to further improve its relationship with coal-producing countries. By promoting its relationship with coal-producing countries and developing coal industries abroad, Japan is trying to secure sufficient coal for a stable coal supply. In 2009, the Japanese government spent more than 5 billion yen on strengthening its relationship with coal producing countries. The budget breakdown included geological surveys, improving coal production and training programs (Ibid.).

In conclusion, it can be said that competition between South Korea and Japan in the field of CCT seems inevitable. South Korea perceives its relationship with countries that have advanced CCT is important and the South Korean government has made efforts for technology exchange; while Japan understands that cultivating a relationship with coal-producing countries is more important because Japan already has advanced CCT. Japan is trying to secure coal and exercise its influence on Asian developing countries by supplying its advanced CCT. Recently, South Korea also joined this trend, securing its coal supply through exporting its CCT. Since its inauguration, the current Lee Myung-bak administration has proclaimed "Green Development", which encourages this trend. Meanwhile, after the Great East Japan Earthquake of March 11, 2011, the Japanese government reexamined its general energy policies, including nuclear power policy prospects. It is certain that coal, which used to be selected as a substitute for oil, will be gaining more importance in Japan as an alternative to nuclear energy. Coal is becoming another hot topic between the two neighbors.

#### CONCLUSION

By comparing the structure of energy consumption of South Korea and Japan, this study shows that the two countries have been trying to escape from their first energy security dilemma, their dependency on oil and the Middle East, by increasing their coal consumption. However, as coal dependency of the two countries grows, South Korea and Japan fell into their second energy security dilemma; as the two countries are increasingly dependent on coal, they have to fight against air pollution. Developing CCT is regarded as one of the most effective ways to solve their second energy security dilemma. Looking into CCT policy trends, South Korea and Japan show signs of competition in this area rather than cooperation. What does this competition between South Korea and Japan, in terms of CCT policies, imply for energy and environmental security in Northeast Asia?

Asia is rapidly growing in this century, and the total demand for energy, especially for electricity, is remarkably increasing. Asian countries, as a whole, are planning to increase their capability of thermal power generation from 550 GW in 1992 to 1350 GW in 2020. This will be on an almost 2.5 times larger scale than 15 years ago (MCIE 2005<sup>29</sup>, 10). Greenhouse gas emission by developing countries will sharply increase, but it is politically complicated to push developing countries into following international regulations; they often claim their right to decide their own economic development. Air pollution is one of the most urgent problems Asia has to deal with. Figure 13 shows how enormously China's CO2 emission has been increasing. In 2009, China produced 29,888,121 thousand metric tons of CO2, which equals 23% of the world's total. Furthermore, SOx emission has grown extensively, mainly due to coal-burning plants. The SOx emission in Asia is predicted to increase to 44 million tons within a decade (lbid., 11).



(Unit: Thousand Metric Ton) Source: UN's Millennium Development Goal Indicators From studying South Korea and Japan, it was proved that developing CCT is an effective way to keep economic growth moving forward and promoting environmental security at the same time. If Asian developing countries put CCT into practical use, they can continue their economic development by depending on coal, and they can decrease their current level of greenhouse gas emissions substantially. However, as we examined in South Korea's case, it is not easy to afford the high cost of developing these technologies. Japan is trying to extend its advanced CCT to certain Asian developing countries, such as China, Indonesia, and Vietnam, based on its national interests, but there are many other countries in need of Japan's help. China has also been developing its own CCT rigorously and its CCT has been remarkably advanced as well. The race for CCT is subtly producing a competitive structure in Asia.

If today's coal competition in Asia goes further, this can cause a sharp conflict within the region, which can negatively affect the world's energy security as the competition surrounding oil did. Different than Europe, Asia seems to lack a regional consensus on establishing a multilateral energy cooperation organization. South Korea is one of the most enthusiastic countries that are willing to promote Northeast Asian energy cooperation. For example, KEEI held the first "International Symposium on Energy Co-operation in Northeast Asia" in June 2001, and the South Korean government suggested forming a Senior Officials Committee (SOC) for Northeast Asian energy cooperation, which would include six Northeast Asian countries: South Korea, Japan, China, Russia, Mongolia and North Korea. While Russia, Mongolia, South and North Korea showed positive reactions toward establishing an inter-governmental cooperation organization, China and Japan were ambiguous. The South Korean government also proposed that the future multilateral energy cooperation organization can build up a regional electricity network or gas network, and it can also share a strategic oil stockpile (Lee 2005<sup>30</sup>; Park 2004<sup>31</sup>). However, multilateral cooperation for coal security has not been fully discussed in spite of its importance in the region.

To conclude, I would like to propose establishing a multilateral cooperation organization for coal security in Asia. The countries, which hold advanced CCT, can transfer their technologies to countries that do not have CCT, and the coal-producing countries within the region can stably supply coal to member states. It can also extend the scope of the organization to other Pacific countries such as the U.S., Canada, and Australia; all of which are major coal producing countries and have advanced CCT as well. These kinds of efforts will contribute to sustainable economic growth and environmental security in the Asian-Pacific region. In order to reach a regional consensus, the related countries need to realize the necessity of a multilateral approach. More frequent dialogues and a task force for research on concrete effects of multilateral cooperation will be necessary.

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