National Communication of the Republic of Korea

1998 Submission of the ROK Under the United Nations Framework Convention on Climate Change

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Foreword

The Republic of Korea, with more than 150 countries, signed the United Nations Framework Convention on Climate Change at the United Nations Conference on the Environment and Development in June 1992. The Republic of Korea became the 47th country to ratify the convention as a non-Annex I country in December 1993.

This National Communication is a part of the Korean Government's effort to comply with Article 12 of the United Nations Framework Convention on Climate Change as well as to abide by an agreement made in 1996 when the Republic of Korea became a member of OECD.

This National Communication shows the Government's determination, as a responsible party to the Convention, to faithfully fulfill its commitments under the Convention in order to prevent global warming and to mitigate greenhouse gas emissions.

In 1994 the Government initiated a number of research projects for the preparation of the National Communication and funded participation from various government ministries and research organizations.

This National Communication consists of chapters dealing with the Republic of Korea's national overview, greenhouse gas emission inventory, policies and measures on greenhouse gases, greenhouse gas emission projection and the impact of climate change on the Korean Peninsula. It also reports the current situation on research activities, international cooperation, and enhancement of public awareness.

Summary

A. National Overview

The Republic of Korea occupies the southern half of the Korean Peninsula, which lies between east longitudes 125°04' and 131°52' and between north latitudes 33°06' and 38°27'. The land area of the Republic of Korea is 99,313 km^2, 65% of which is mountainous forest area. The forests in the Republic of Korea were devastated from firewood consumption in the wake of the Korean War, but have recovered as a result of successful afforestation since the 1970's.

The climate in the Republic of Korea is temperate, with four distinct seasons, as it is located in the middle latitudes. There are systematic seasonal influences over the Korean Peninsula from the Asian continent and the Pacific Ocean so that summers are hot and humid while winters are cold and dry. Average temperatures in August, the warmest month, range from 20° to 26°C and average temperatures in January from -5° to 3°C.

The Republic of Korea's population in 1996 was 45.5 million and the population density was 459 persons per km^2, the third highest in the world. However the effective implementation of family planning policies has slowed the population growth rate from 3.0% in 1960 to less than 1% at the present.

The Republic of Korea's economy has changed markedly in every respect over the past 30 years since the early 1970's when the Government launched its series of economic development plans. The average economic growth rate during the last decade was recorded at over 8.8% per annum, which is far higher than the moderate growth rate of around 2% of some developed economies. The high rate of economic growth inevitably led to the rapid growth of energy consumption.

The Republic of Korea's GDP was US$ 457 billion (per capita GDP US$10,124) in 1995. The Korean industrial structure has experienced a major shift from agriculture, forestry and fishing, and mining industries to manufacturing and service industries. The share of agriculture, forestry and fishing in total GDP sharply decreased to 6.4% in 1995 from 26.6% in 1970. Since the 1980s, the heavy and chemical industries have grown rapidly, with their share of GDP rising to 76.2% of the total manufacturing sector in 1996. The increase in

industrial activities boosted the growth of energy consumption and GHG emissions.

B. Economic Growth and Energy Consumption

Expansion of the heavy and chemical industries has been the major impetus to industrializing the economy, pushing the average growth rate to 9.4% per annum in 1981-1990 and 7.4% per annum in 1991-1996. To fuel the rapid economic growth, primary energy consumption also increased from 43.9 million TOE in 1980 to 165.2 million TOE in 1996, a growth rate of 7.8% per annum from 1980-1990 and 10.0% from 1991-1996. The combination of stable population growth and a rapidly growing economy brought about an increase in per capita energy consumption that reached 3.63 TOE in 1996. Nevertheless, the per capita energy consumption in the Republic of Korea is still lower than the average among other OECD countries. Analogous to most of the advanced countries at the early stages of their economic development, the Republic of Korea to date has been achieving a high rate of economic growth coupled with rapidly growing energy consumption.

The Republic of Korea is not endowed with significant natural resources, and anthracite coal is the only indigenous energy resource that has been commercially produced and sold. Most energy resources are imported from overseas. Since the onset of economic growth, foreign energy dependency (including nuclear power) has been high. Of particular note, it jumped from 73.5% in 1980 to 87.9% in 1990, and further to 97.8% in 1996. Not only has the absolute amount of the total energy consumption increased, but also the composition of the energy mix has changed. The demand for clean and convenient sources of energy such as oil and natural gas has increased at the expense of domestic coal since the mid-1980's.

The primary sources of energy in the Republic of Korea consist mainly of oil, coal, and natural gas. As in most countries, the major source of energy in Korea has been oil and its consumption has increased from 182,105 kBbl in 1980 to 356,349 kBbl in 1990 and to 721,063 kBbl in 1996. The increase in oil demand has come in part from the expansion of petrochemical facilities in the 1990s and in part from the inter-fuel substitution of oil for coal during the same period. In fact, oil consumption increased at 6.9% a year in the 1980's and 12.4% in the 1990's, representing 60.5% of total primary energy in 1996.

Coal is used in the steel and cement industries as well as power generation in Korea. Its consumption increased from 25,862 kTon in 1980 to 43,405 kTon in 1990 and to 50,277 kTon in 1996. The share of coal in primary energy consumption rapidly decreased from 30.1% in 1980 to 19.7% in 1996. The annual average growth rate of coal consumption

between 1991 and 1996 was only 2.4%. Such a low rate of growth demonstrates the anticipated outcome of the government's "rationalization of coal industry" policies in response to rising public concerns about environmental issues.

In 1987, 1,620.7 thousand tonnes of LNG were consumed in Korea, and its consumption has increased rapidly, reaching 9,361 thousand tonnes in 1996 (an increase of 5.8 times). The Government encouraged the expansion of LNG supply in order to reduce heavy reliance on petroleum and diversify energy sources. Consumers' preference for cleaner energy also played an important role in boosting natural gas consumption.

The electricity generation sector in Korea has expanded to meet growing electricity demand accompanying economic growth and improving living standards. On the supply side, nuclear power generation programs have been actively pursued by the Government in order to reduce the heavy reliance on fossil fuel in Korea. Since the first plant began operations in 1978, the total number of nuclear power plants has now reached 12. The total electricity generated by nuclear power plants reached 73,924GWh in 1996, about 11.2% of primary energy consumption. As of 1996, the shares of nuclear, coal, oil, LNG, and hydro in terms of total power generation were 36.0%, 27.6%, 20.7%, 13.5% and 2.5%, respectively.

Final energy consumption increased from 37.597 million TOE in 1980 to 75.107 million TOE in 1990 and to 132.033 million TOE in 1996.

The annual average growth rate of final energy consumption was 7.2% between 1981 and 1990, and 9.9% between 1991 and 1996. In 1996, the industrial sector accounted for 51.4% of total final energy consumption, while transport stood at 22.6% and residential and commercial combined for 24.0%.

Energy consumption in the industrial sector has increased and the demand for bituminous coal has steadily escalated in the steel and electricity industries. The transport sector energy consumption has surged due to the increase in the number of passenger cars during the last three decades. In the residential and commercial sector, there has been rapid inter-fuel substitution of natural gas for coal in the form of city-gas. The share of coal in this sector dropped from 61.8% in 1980 to 3.3% in 1996.

The Government to date has undertaken various measures to implement energy diversification more efficiently and instituted efficiency improvement policies in the 1990's, aiming to transform the energy consumption sectors into being less carbon-intensive. As a consequence, the share of coal in terms of primary energy has markedly dropped from 26.2% in 1990 to 19.7% in 1996, while the share of LNG has risen from 3.2% to 7.4% over the same period.

Source: Yearbook of Energy Statistics, 1997, KEEI.

C. Inventory of Greenhouse Gas Emissions and Removals

The base year for inventory of greenhouse gas emissions and removals in Korea is 1990 and the inventory methodology adopted was "IPCC guidelines for national greenhouse gas inventories in 1995." The inventories were established for six gases including direct GHGs such as CO_2, CH_4, and N_2O, and indirect GHGs such as NO_x, CO, and NMVOC. CO_2 emissions from fossil fuel consumption in the energy sector from 1991 to 1995 were calculated with international bunkering being separately listed. In the agricultural sector, CH_4 emissions from rice paddies and livestock were calculated with a slightly different method tailored to allow for circumstances peculiar to Korea.

In order to calculate the GWP index for direct greenhouse gases, the 1996 IPCC GWP was employed. With a 100-year-time-horizon GWP index, the contribution of CO_2 was 87.7% and that of CH_4 10.9%. In particular, the contributions of GHG emissions from the energy sector to the total GWP value are 95.5% so that substantial efforts to mitigate GHG in the energy sector are certainly necessary. The reliability of the non-CO_2 emissions inventory of

		1980	1985	1990	1994	1995	1996	AAGR (%) 81	AAGR (%) 91
Energy Consumption (1,000 TOE)	Primary	43,911	56,296	93,192	137,235	150,437	165,209	8	10
	Final	37,597	46,998	75,107	112,206	121,850	132,033	7	9
Per Capita Energy Consumption (TOE/Person)		1.15	1.38	2.17	3.09	3.35	3.63	7.	8
Dependency on Imported Energy (%)	Nuclear included	73.5	76.2	87.9	96.4	96.8	97.8		
	Nuclear excluded	71.6	68.8	73.7	85.7	85.6	86.1		
Share of Petroleum in Primary Energy Consumption		61.1	48.2	53.8	62.9	62.5	60.5		
Share of Electricity in Final Energy Consumption		7.5	9.3	10.8	11.2	11.5	11.9		
Energy Price Index		71.7	141.0	100.0	115.54	121.4	137.9		
Energy/GDP Ratio (TOE/Million Won)		0.58	0.51	0.52	0.58	0.58	0.60		
Economic Growth Rate(%)		-2.7	6.5	9.5	8.4	8.7	6.9	9	7
Growth Rate of Primary Energy Consumption(%)		1.5	5.4	14.1	8.1	9.6	9.8		
Energy Elasticity		-	0.83	1.48	0.96	1.10	1.41		

Major Energy and Economic Indicators in Korea

other sectors including agriculture, forestry, waste management and industrial processes is significantly hampered by the lack of accumulated input data. To make the emissions inventory for these sectors more reliable in the future, the Korean Government will take measures to modify ways to collect, process, and report the necessary inventory data.

In Korea, net CO_2 emissions in 1990 were 230,278 Gg, equivalent to 62.8 million TC. Total emissions were 256,513 Gg and forest removals were 26,235 Gg, which were 10% of total emissions. It should be noted, however, that the net emissions in the table did not take into account international bunkering.

In 1990, CO_2 emissions from fossil fuel combustion amounted to 238,990 Gg. CO_2 emissions from fossil fuel combustion in the industry sector contributed the largest share, accounting for 37% of total CO_2 emissions. The residential/commercial sector was the second largest source of CO_2 emissions, with a share that was 27% of the total, while the shares for transport, public, and electricity generation sectors were 18%, 3%, and 16%, respectively.

The CO_2 emissions from fossil fuel combustion increased at an annual rate of 9% during the period 1990-1995. In the same period, CO_2 emissions from electricity generation had the highest average growth rate of 17%, transport 14%, industry 9%, and commercial/residential 1%. In 1990, methane emissions were 1,362 Gg, 30.4% of which came from rice paddies.

Note: 1) non-CO emissions are those from residential and commercial sectors in 1989
2) non-CO2 emissions are those from public and other sectors in 1989

Category	CO_2	CH_4	N_2O	NOx	CO	NMVOCs
Net Emissions	230,278	1,362	12	851	1,056	152
1. Energy-Related Emissions	238,990	264	11	851	1,056	152
A. Fuel Combustion	238,990	17	11	851	1,056	152
1. Energy Transformation	37,934	0.3	2	193	7	N.A.
2. Industry	87,282	1	2	135	25	N.A.
3. Transport	42,198	6	2	401	600	152
4. Residential and Commercial [1)]	64,592	7	3	105	364	N.A.
5. Public and Other [2)]	6,985	0.5	4	16	39	N.A.
6. Biomass Burning	-	2	0.02	0.6	20	N.A.
B. Fugitive Fuel Emissions	-	246	-	-	-	-
1. Coal Mining	-	230	-	-	-	-
2. Oil and Gas Systems	-	16	-	-	-	-
2. Industrial Processes	17,512	5	-	-	-	-
A. Cement Industry	14,841	-	-	-	-	-
B. Limestone and Dolomite Use	2,459	-	-	-	-	-
C. Soda Ash Use	212	-	-	-	-	-
D. Chemical Industry	-	5	-	-	-	-
3. Agriculture	-	599	1	-	-	-
A. Rice Fields	-	414	-	-	-	-
B. Enteric Fermentation	-	144	-	-	-	-
C. Animal Excrement	-	41	-	-	-	-
D. Nitrogen Fertilizers	-	-	1	-	-	-
4. Waste Management	11	495	-	-	-	-
A. Waste Incineration	11	-	-	-	-	-
B. Landfills	-	200	-	-	-	-
C. Household Wastewater	-	21	-	-	-	-
D. Industry Wastewater	-	274	-	-	-	-
5. Total	256,513					
6. Removals (Managed Forest)	-26,235	-	-	-	-	-
7. International Bunkering	7,140	-	-	-	-	-

Greenhouse Gas Emissions/Removals in Korea (1990) (unit : Gg)

D. Projection of Energy Demand and CO2 Emissions

The Rational Energy Utilization Act makes it mandatory to establish a basic 10-year National Energy Plan and to revise it every five years to reflect changes in economic circumstances and population growth. The plan is a rolling plan by nature, and a long-term energy demand projection is a part of the plan.

As a vehicle for projecting energy demand in Korea, a modified version of the LEAP model, which has been tailored to meet the Korean socio-economic structure, is employed. In parallel, a long-term electricity demand projection using the WASP model was made as a reference. IPCC methodology has been adopted for the calculation of CO2 emissions.

Economic growth is an important factor determining future energy demand. The energy demand projection was based on the assumptions of the economic growth forecast in the Long-term Economic Management Plan of 1992, with the actual energy consumption data for 1996 as a starting point.

According to the Long-term Economic Management Plan, GDP will increase by 2.37 times from 1995 to 2010, population by 1.11 times, the number of households by 1.28 times, and the number of automobiles by 3.55 times.

The projected energy demand exhibits a steady growth from 150.4 million TOE in 1995 to 328.1 TOE in 2010. The annual average growth rate of energy demand between 1996 and 2010 is projected to be 5.3%.

	1985	1990	1995	2000	2005	2010	AAGR(%)	
							86-95	96-10
Primary energy demand	56.3	93.2	150.4	213.4	272.9	328.1	10.3	5.3
Final energy demand	47.0	75.1	121.9	169.9	212.6	251.2	10.0	4.9
Energy/GDP	0.51	0.52	0.58	0.60	0.58	0.54	1.5	-0.6
Per capita energy consumption	1.4	2.2	3.4	4.6	5.7	6.6	9.3	4.6

Energy Demand Projection (unit: million TOE, TOE/90 million Won, per capita TOE)

The results show that the corresponding CO2 emissions would increase, at an annual average rate of 5.2%, from 101.1 million TC in 1995 to 217 million TC in 2010.

	1985	1990	1995	2000	2005	2010	AAGR(%)	
							86-95	96-10
CO_2 emissions	44.0	65.2	101.1	148.5	187.4	217.0	8.7	5.2
Per capita CO_2 emissions	1.1	1.5	2.3	3.2	3.9	4.4	7.7	4.5
CO_2 /GDP	0.39	0.36	0.39	0.42	0.40	0.36	-0.1	-0.7

CO_2 Emissions Projection (unit: million TC, per capita TC, TC/ 90 million Won)

Energy demand forecasts vary to a great extent with changes in economic growth and investments in energy efficiency improvement. At the end of 1997, Korea is, unfortunately, experiencing serious financial difficulty, receiving IMF rescue funds.

As this financial crisis is likely to hamper economic growth and capital investment in energy efficiency improvement, a downward adjustment to the current energy consumption projection seems inevitable.

The Korean Government is now conducting a revision of the energy demand forecast taking fully into account repercussions of the current crisis on the future course of energy demand. The outcome of such revision will be made available in the next National Communication.

E. Impact of Climate Change on the Korean Peninsula

As the Korean Government recognized the potential significance of climate change, it began to fund basic researches for a climate change impact assessment. Outcomes of the government funded studies in recent years indicated that serious consequences would follow if CO_2 concentration around the Korean Peninsula doubled.

The main consequences might include changes in temperature, as well as in the amount of precipitation and river flows. According to the studies, the temperature could rise by 1.0-4.0? , and amounts of precipitation and river flows would also increase. The southern coastal areas would be transformed to a subtropical zone from a temperate zone.

While latent crop productivity might increase due to a prolonged summer season, it is anticipated that it would be difficult to maintain normal levels of production of perennial temperate zone fruits. Land areas available for cultivating semi-temperate zone vegetation would expand.

But temperate zone and semi-boreal zone vegetation would decrease exponentially in diversity and some would be in danger of extinction. Marine life around the Korean Peninsula would also face serious consequences including a decrease in the number of cold-water aquatic species.

F. Greenhouse Gas Emission Mitigation Policies and Measures

After ratifying the Climate Change Convention in December 1993, environmental consideration became an important factor in policy-making. Considering its heavy dependency on foreign imports for energy resources, the Korean Government has been undertaking a variety of measures to promote the rational use of energy and has intensified its comprehensive efforts to reduce greenhouse gas emissions to combat global warming

Energy Sector

The Government has been focusing on energy conservation policies as the most effective measures to mitigate greenhouse gas emissions, After the global oil crises of the 1970s, energy conservation policies were adopted which were later reinforced after the Rio Environment Conference of 1992.

In 1974, the Heat Management Act was enacted to implement energy conservation

policies systematically. In 1979, the Korean Government began implementing comprehensive and aggressive policies based on the Rational Energy Utilization Act, which replaced the Heat Management Act.

The National Committee for Energy Conservation was established in 1997 to implement efficient energy conservation policies. Its members consisted of experts from both private and public sectors. To help motivate energy conservation efforts, the Rational Energy Utilization Act was revised in 1997 to include a clause on early-notification of energy price changes.

Based on the Rational Energy Utilization Act, the Government enhanced it efforts to build a low-energy consumption industrial structure with various energy conservation and efficiency improvement policies for industry, transport, and residential sectors.

To illustrate, in the industry sector the Government has been promoting "the 5-Year Energy Conservation Plan of Energy Intensive Companies," replacement and renovation of old and inefficient boilers and furnaces, diffusion of high efficiency motors, and co-generation.

In the transport sector, it has been trying to improve energy efficiency in motor vehicles through mandatory fuel efficiency labelling as well as fuel economy targets.

Also in the residential sector, the Government has enhanced energy efficiency labelling, minimum energy efficiency standard and district heating systems, which aim to induce rational use of energy by residential consumers.

The Government has carried out strong inter-fuel substitution polices by way of expanding natural gas consumption, nuclear power programs, and new and renewable energy development. The expansion of gas consumption will be enhanced by the construction of new receiving terminals and a nation-wide pipeline grid.

For the expansion of nuclear power programs, 16 new units of nuclear power plants will be added to the current 12 nuclear power generation units. This will raise the share of nuclear power generation in terms of total electricity generation to 45.5% by 2010 from 36% in 1996.

The Government has targetted the supply of 2% of total primary energy by 2006 through new and renewable energy technology development. This target is supported by the "Ten-Year Energy Technology R&D Plan, 1997-2006," that integrates technology for energy

conservation, new and renewable, and clean energy into a single, systematic, and yet comprehensive energy technology development program to facilitate energy savings through technology development.

In an effort to reduce carbon dioxide emissions, the Korean Government has imposed duties on the import of petroleum products and LNG (Liquefied Natural Gas) and taxes on sales of kerosene, LPG (Liquefied Petroleum Gas) and LNG.

All revenues from these energy taxes have been deposited in the Special Energy Account and used for energy conservation, district heating, and R&D projects, which are generally considered carbon dioxide reduction measures. Even though the amount of energy taxes is not directly linked to the level of carbon content contained in different energy sources, these taxes play the role of carbon taxes.

The Government plans to allow the level of energy prices to rise gradually to those of non-oil producing OECD countries by shifting away from its low energy price policies of the past. High energy prices will send a strong signal to energy consumers that the Government is serious about controlling consumption.

There also will be incentives for saving energy and making investments in development and adoption of efficient energy technologies. In addition, the Rational Energy Utilization Act was revised in 1995 mandating energy supply companies to establish and execute demand side management (DSM) and investment plans.

Under the 1995 revision of the Rational Energy Utilization Act, major energy suppliers including Korea Electric Power Corporation and Korea Gas Corporation have developed long-term plans for DSM since 1996 to improve efficiency and control load management programs.

Forestry Sector

The Government has implemented policies to protect existing forests and to enhance the carbon pool. Included in these policies are forest planning, designation of reserve and protective forests, and control of forest fires, disease and pests as laid out in the Forest Law. In an effort to expand the carbon pool, the Government has been carrying out afforestation and reforestation with superior species.

Agriculture & Animal Husbandry Sector

The Government has been conducting and recommending agricultural policies and practices to mitigate GHG emissions from the agricultural sector. The policies in the agricultural sector include recommending agricultural practices effective in methane mitigation in rice paddies and providing guidance to farmers for methane mitigation. In the animal husbandry sector, methane emission mitigation policies include restraining enteric fermentation and promoting effective manure management.

Waste-management Sector

The Government has undertaken waste management polices for waste reduction, recycling, incineration and landfills. In order to carry out systematic management of waste the Government established the National Plan for Integrated Solid Waste Management in 1993 and revised and supplemented it in 1996. This plan aims to manage solid wastes effectively and systematically.

Sector	Policies and Measures
Energy	
Energy Conservation - Industrial Sector	Target Energy-Intensity Level by Product, Five-Year Energy Conservation Plan for Energy-Intensive Industry, Cogeneration
- Residential Commercial Sector	Housing Insulation, Energy Efficiency Grading System, Mi Efficiency Standards, District Heating
- Transportation Sector	Fuel Efficiency Labelling Program, Fuel Economy Targets
Interfuel Substitution	Nuclear Power Generation, LNG, NRSE
Energy Technology Development	Ten-Year Energy Technology R&D Plan
Demand Side Management	Energy Pricing System, Long-term Plan for DSM
Forestry Sector	
Forestry Protection	Forest Planning, Designation of Reserve and Protected Forests
Carbon Pool Expansion	Afforestation, Reforestation with Superior Species
Agriculture & Animal Husbandry Sector	
Methane Gas Mitigation	Agricultural practices effective in methane mitigation of rice paddies Guidance to farmers for methane mitigation of rice paddies, Limiting enteric fermentation and promoting effective manure management.
Waste Sector	
Waste Reduction Waste Recycling	Volume-based Waste Fee System, Discouragement of Disposable Product Usage, Separation/Collection System Waste Fine System, Deposit System

Summary of Greenhouse Gas Mitigation Policies and Measures

G. Future Directions

To limit future CO_2 emissions effectively, the Government will continue to implement policies that encourage voluntary participation of both public and private sectors in addition to current policies that have been carried out.

For this purpose, the Government will exploit financial incentives, and will consider and implement measures to mitigate CO_2 emissions through voluntary agreement between the Government and industry. If necessary, the Government will take further actions to enact laws promoting more effective mitigation measures.

The Government will also make efforts to enhance awareness of industry and the general public regarding UNFCCC. The significance for and potential impact of UNFCCC on Korea will be publicized through public forums, publication of pamphlets and guidebooks, and the use of mass media.

To encourage rational energy use, education opportunities for industry and the general public will be provided. Early education programs on energy conservation will be strengthened to enhance awareness among primary, middle and high school students, the future leaders of the nation.

The Government will also encourage the industrial sector to design management plans that take into account the limitation of CO_2 emissions in accordance with UNFCCC. In addition, the Government will make efforts to obtain concrete results by implementing new policies. It will also require energy suppliers to devise and carry out plans to enhance efficiency improvements so that demand management investment can be expanded. The Government will implement measures to minimize costs and losses incurred by energy suppliers from such investments.

The role of the central and local governments will be coordinated so that regional energy plans, fully taking into account unique regional circumstances, can be established.

Support for regional energy projects will be continuously expanded and at the same time local governments will be encouraged to enhance awareness and capabilities regarding greenhouse gas issues.

Korea will make an extensive effort to expand the scope of the next National

Communication. First of all, emphasis will be given to minimizing the uncertainty of CO_2 emission forecasts and adding inventories and demand projections for the emission of greenhouse gases other than CO_2. Second, mitigation policies for each greenhouse gas and each industry will be presented, and a concrete and quantitative analysis on how each policy can contribute to mitigation will be included. Adaptation measures for climate change will also be studied.

Korea will make its best effort to mitigate and prevent climate change within its economic and social capabilities, and will strengthen bilateral and multilateral international cooperation so that these efforts can be pursued most effectively.

1 Natural Environment and Economy

1. Land Use

1.1. Geography

The Republic of Korea (ROK) occupies the southern half of the Korean Peninsula, which is split by the Demilitarized Zone, and is located in Far East Asia between China and Japan. The national boundary is defined by four points in terms of longitude and latitude. The eastern-most point is Tok-to at east longitude 131° 52`; the western-most point is Sohuksan-to at east longitude 125° 04'; the northern-most point is Songhyunjin at north latitude 38° 27`; and the southern-most point is Mara-to at north latitude 36° 06`. The land area of the ROK encompasses 99,313 km^2 as of 1996.

1.2. Land Use

The ROK has a rugged and mountainous terrain, of which forested areas account for 65,396 km^2 as of 1996, 65.9% of total land area.

	1992	1993	1994	1995	1996
Total Area	99,314(100)	99,392(100)	99,394(100)	99,268(100)	99,313(100)
Agricultural Area	22,185(22.4)	22,129(22.3)	22,025(22.1)	21,971(22.0)	21,925(22.1)
Forest Area	66,689(66.1)	65,711(66.1)	65,665(66.1)	65,506(65.8)	65,396(65.9)
Other Area	11,440(11.5)	11,552(11.6)	11,704(11.8)	11,791(12.2)	11,992(12.0)

< Table 1-1 > Land Use Categories

(Unit : ? , %)

Note: Agricultural areas include cultivated land and pastures.
Source: Land Registration Statistical Yearbook, 1997, Ministry of Internal Affairs.

Agricultural land consists of 21,925 km^2, 22.1% of the total area. However, as economic

development intensifies, the amount of land for agriculture and forests is diminishing and is expected to continue to fall with further development. Meanwhile, the land for residential and commercial use, such as for homes, roads, factories and parks, is anticipated to expand.

1.3. Agriculture

1.3.1. Land Use for Agriculture and Fertilizer Consumption

The area of agricultural land has decreased 29.1 thousand ha.on an annual average for the past five years as land development, including the construction of public facilities and buildings, is facilitated and, at the same time, the area of unused arable land has become larger. As of 1996, the total agricultural area was 1,945 thousand ha, 40 thousand ha. less than in 1995. Of the agricultural land area, the size of rice fields was reduced to 1,176 thousand ha., down 30 thousand ha., and uplands to 769 thousand ha., down 10 thousand ha., from the previous year.

Total agricultural area utilized in 1996 was 1,945 thousand ha, 55 thousand ha. less than in previous year. The utilization ratio of agricultural land fell to 107.9% in 1996 from 108.1% in the previous year. The primary reason for this was that theareas used for food crops was reduced by 6,000 ha. and the areas for vegetables and fruits by 49 thousand ha. The unutilized arable land area was 34.3 thousand ha.in 1996, a decline of 30.3 thousand ha. from the 1995 total as an outcome of intensive efforts to make full use of arable land.

	Total		Rice fields		Uplands	
		%		%		%
1990	2,109	100	1,345	63.8	763	36.2
1992	2,070	100	1,314	63.5	755	36.5
1994	2,033	100	1,267	62.3	765	37.7
1995	1,985	100	1,205	60.7	779	39.3
1996	1,945	100	1,176	60.5	769	39.5

< Table 1-2 > Agricultural Land Use

(Unit: thousand ? .)

Source: Statistical Yearbook of Agriculture and Forestry, 1997, Ministry of Agriculture and Forestry.

The area of rice fields has decreased gradually from 1,345 thousand ha.in 1990 to 1,176 thousand ha. in 1996. Nitrogen fertilizer used in rice farming is a major source of N_2O emission. As the area of rice fields fell, the associated nitrogen fertilizer consumption also fell. Nitrogen fertilizer comprises about 50% of total fertilizer consumption.

	Total	Nitrogen	Phosphorous	Potash
1990	998	523	223	252
1992	822	428	184	210
1994	820	424	185	211
1995	811	419	183	209
1996	788	412	175	201

< Table 1-3 > Fertilizer Consumption

(Unit: thousand tons)

Source: Statistical Yearbook of Agriculture and Forestry, 1997, Ministry of Agriculture and Forestry.

1.3.2. Livestock

Methane (CH_4) is produced by fermentation in animal intestines and microbial decay of animal excrement. The number of livestock and poultry has increased significantly since meat has become increasingly popular as a daily foodstuff. The number of livestock increased from 9,473 thousand in 1991 to 12,568 thousand in 1996. The trend is expected to continue as meat consumption grows.

		1991	1994	1995	1996
Ruminants	Native Beef Cattle	1,772	2,392	2,594	2,843
	Dairy Cattle	495	552	553	551
Others	Chickens	74,855	80,569	85,799	82,829
	Pigs	5,046	5,955	6,461	6,515
Total		82,168	89,468	95,407	92,738

< Table 1-4 > Number of Livestock

(Unit: thousand)

Source: Statistical Yearbook of Agriculture and Forestry, each year, Ministry of Agriculture and Forestry.

1.3.3. Forestry

Forests in Korea had been devastated as a result of Koreanwar and firewood consumption for fuel use in the 1960s, but have recovered to a significant degree with the Forestry Plans creating afforestation and forestry resources improvement from 1973. The first and second plans covering the 1973-1987 period were successfully implemented. The third plan for 1988-1997 focused on quality improvement of new forests and on the establishment of a sustainable management system. These plans have helped the average forest-growing stock per hectare to reach 50.21? as of the end of 1996.

	Land Area (thousand ha.)	Stock (thousand?)	Stock per ha. (?)
1970	6,611	66,750	10.07
1975	6,635	105,352	15.88
1980	6,568	145,694	22.18
1985	6,531	179,381	27.47
1990	6,476	248,426	38.36
1996	6,448	323,780	50.21

< Table 1-5 > Variations in Land Area and Forest-Growing Stock

Source: Statistical Yearbook of Agriculture and Forestry, 1997, Ministry of Agriculture and Forestry.

By forest type, about half the forest area consists of coniferous trees and the remaining half, nonconiferous and mixed.

The areas of coniferous trees are decreasing in size, while those of nonconiferous species are increasing.

	Total	Conifers	Nonconifers	Mixed	Bamboo Stands
1990	6,286	3,078	1,389	1,809	8
	(100)	(49.0)	(22.1)	(28.8)	(0.1)
1994	6,274	2,882	1,668	1,714	8
	(100)	(45.9)	(26.7)	(27.3)	(0.1)
1995	6,263	2,877	1,668	1,710	8
	(100)	(45.9)	(26.7)	(27.3)	(0.1)
1996	6,255	2,846	1,674	1,727	8
	(100)	(45.5)	(26.8)	(27.6)	(0.1)

< Table 1-6 > Forest Land Area by Forest Type

(Unit: thousand ha.)

Source: Statistical Yearbook of Agriculture and Forestry, 1997, Ministry of Agriculture and Forestry

1.4 Coastal Areas

Except for Korea's northern border, the country is surrounded by coastal areas. To the west sits the Yellow Sea, bounded by China and the Korean Peninsula. The Yellow Sea is about 1,000 km long and about 700 km wide. Excluding Balhai, it covers about 404,000 km^2. The South Sea is the northern section of the East China Sea. The East Sea, 1,600 km long and 1,000 km wide, covers 1,007 thousand km^2.

2. Climate

2.1. Temperature

Since Korea is located in the middle latitudes, its climate is temperate with four distinct seasons . Influenced by the Asian continent and surrounding oceans, it is hot and humid in summer while cold and dry in winter.

Annual average temperatures ranged from 10.6°C to 15.9°C for the past 30 years, but in recent years (1990-1996) the average temperatures ranged from 12.2 to 13.5°C. The coldest month is January and the warmest month is August. In August, the monthly average temperature is between 20°C and 26°C. The monthly average temperature in January is

between -5°C and 5°C.

2.2. Cooling/Heating Degree Days

Cooling/Heating Degree Days are major indicators reflecting energy consumption. Cooling/Heating Degree Days are directly related to temperature.

On average, heating degree days in Korea are between 2,500 and 3,000 and cooling degree days are 600-700. In recent years, the greatest cooling degree days were 909 in 1994 and the least were 451 in 1980. The greatest heating degree days were 3,069 in 1984, while of those in 1989, 2,475, were the least.

	Average Temperature (?)	Heating Degree-Days	Cooling Degree-Days
1980	10.8	3,081.0	451.0
1984	11.6	3,069.0	721.0
1989	13.0	2,475.0	661.0
1994	13.5	2,511.0	909.0
1995	12.2	2,738.9	646.3
1996	12.2	2,843.9	742.3

< Table 1-7 > Cooling/Heating Degree Days (in Seoul)

Source: Yearbook of Energy Statistics, Korea Energy Economics Institute.

	City	Temperature		
		Highest	Lowest	Yearly Average
Korea	Seoul	25.2	-3.3	11.7
Japan	Tokyo	27.1	5.2	15.6
U.S.A.	Washington	26.3	1.4	14.3
France	Paris	18.4	3.5	10.6
United Kingdom	London	16.5	3.8	9.7
Australia	Canberra	20.4	5.4	13.0

< Table 1-8 > Temperatures (?) of World Major Cities

Source: International Statistical Yearbook, 1997, National Statistical Office.

3. Population

3.1 Trends of Population Growth

The Republic of Korea's population in 1996 was 45.545 million. The population growth rate in the same year was recorded at 1.0%. The population growth rate, 3.0% in 1960 and 2% in 1970, has decreased to less than 1% since 1985 due to improved socio-economic conditions, changes in public attitude towards the population problem and the government's family planning policy.

Recently, the population growth rate in Korea has been around 1%, slightly higher than the 0.5% average growth rate in developed countries, but significantly lower than developing countries' 2.1%. Population density in Korea in 1996 was 459 persons per km^2, the third highest in the world excluding small island nations or city-states.

	1960	1970	1980	1985	1990	1994	1995	1996
Total Population (thousand)	25,012	32,241	38,124	40,806	42,869	44,642	45,093	45,545
Population Growth Rate (%)	3.00	2.21	1.57	0.99	0.99	1.01	1.01	1.00
Population Density (persons/?)	254	328	385	412	432	449	454	459

< Table 1-9 > Population Size and Density

Source: Korea's Major Economic Indicators, 1997, National Statistical Office.

3.2 Projected Population Growth

The Republic of Korea's population will reach 46.8 million by 2000 and 49.7 million by 2010. The population growth rate is expected to slow gradually to 0.83% between 1996-2000 and to 0.60% between 2001-2010.

	Population (million)	Yearly Average Growth Rate (%)	
		Period	Growth Rate
2000	46.8	1996-2000	0.83
2010	49.7	2006-2010	0.60

< Table 1-10 > Projected Population Growth

Source: Korea Statistical Yearbook, 1996, National Statistical Office.

4. Economy

4.1 Gross Domestic Product (GDP)

In terms of 1990 constant prices, ROK's GDP increased 7.6 times to 275.8 trillion Won in 1996 from 36.3 trillion Won in 1970. As a result, per capita GDP increased 5.2 times from 1.155 million Won in 1970 to 6.056 million Won in 1996. TheROK's GDP was US$457 billion and per capita GDP was US$10,124 in 1995.

Source: Economic Statistics Yearbook, each year, Bank of Korea.

	Year	1970	1975	1980	1985	1990	1994	1995	1996
GDP	Trillion Won	36.306	53.670	75.466	111.330	179.539	236.375	257.536	275.850
Per Capita GDP	Thousand Won / person	1,155	1,521	1,980	2,728	4,188	5,249	5,710	6,056

< Table 1-11 > Major Economic Indicators (1990 constant Won)

	1986		1990		1993		1994		1995	
	GDP	Per capita GDP	GDP	Per capita GDP	GDP	Per capita GDP	GDP	Per capita GDP	GDP	Per capita GDP
Japan	1,986	16,344	2,932	23,734	4,190	33,612	4,591	36,739	5,111	40,819
Germany	888	14,522	1,504	23,780	1,726	23,503	1,835	25,133	2,414	29,569
U.S.A.	4,269	17,736	5,522	22,097	6,553	25,385	6,936	26,608	7,254	27,578
France	732	13,176	1,195	21,072	1,250	21,677	1,331	22,988	1,539	26,518
Canada	364	14,356	574	21,588	553	19,094	547	18,707	566	19,103
United Kingdom	564	9,923	979	17,001	946	16,260	1,024	17,500	1,106	18,977
Australia	167	10,104	295	16,457	284	15,555	324	17,594	349	18,605
Korea	109	2,635	254	5,916	333	7,530	381	8,528	457	10,124

< Table 1-12 > GDP of Major Countries
(Unit: billion US$ for GDP, US$ for per capita GDP)

Note: Current price basis

Source: International Statistical Yearbook, 1997, National Statistical Office.

4.2 Economic Growth Rate

Since the 1960s when the Korean government launched a series of Economic Development Plans, high economic growth rates have been recorded. In particular, for the period 1986-1995, Korea achieved a marked economic growth of 8.8% per annum, while the developed countries showed moderate growth rates of 2-3%.

	1986	1990	1993	1994	1995
Korea	11.6	9.5	5.8	8.6	8.9
Australia	1.8	1.4	4.0	4.9	3.2
United Kingdom	4.3	0.4	2.1	3.8	2.5
Canada	3.3	-0.2	2.2	4.1	2.3
France	2.5	2.5	-1.3	2.8	2.2
USA	2.9	0.8	2.2	3.5	2.0
Germany	2.3	5.8	-1.2	2.9	1.9
Japan	2.6	4.8	0.1	0.5	0.9

< Table 1-13 > Economic Growth Rates of Major Countries (Based on 1990 constant price)
(Unit : %)

Source: International Statistical Yearbook, 1997, National Statistical Office.

4.3 Current Account Balance and Foreign Debt

Even though Korea has achieved remarkable economic growth since 1970, its current account deficit has expanded. The trade deficit is growing due to high production costs, and the non trade deficit is growing due to the rapid increase in overseas travel. Except in 1993 when Korea had a current account surplus, the deficit was growing and recorded at US$4.5 billion in 1994 and US$8.9 billion in 1995.

	1986	1990	1993	1994	1995
Korea	4.6	-2.2	0.4	-4.5	-8.9
China	85.8	35.9	132.0	130.6	111.3
India	-10.4	-22.6	-23.4	-17.3	-8.7
Indonesia	-150.5	-94.3	-99.7	-147.7	-148.2
Thailand	2.4	-9.9	9.0	7.0	16.4
Turkey	40.9	48.1	-13.4	-20.3	-20.8
Argentina	-1.3	-32.5	-16.2	-3.5	-6.2
Brazil	-9.9	-16.1	-10.5	-17.3	-19.2

< Table 1-14 > Current Account Balances of Major Countries
(Unit: billion US$)

Source: International Statistical Yearbook, 1997, National Statistical Office.

Accordingly, foreign debt was also growing rapidly. Foreign loans to Korea, which stood at US$27.2 billion in 1980, grew to US$56.9 billion in 1994.

	1980	1990	1992	1993	1994
Korea	272	317	428	439	569
China	45	528	598	842	1,005
India	206	820	898	921	990
Indonesia	209	700	883	895	965
Thailand	83	282	396	458	610
Turkey	191	492	565	688	663
Argentina	272	622	654	706	774
Brazil	729	1,215	1,305	1,454	1,511

< Table 1-15 > Foreign Debts of Major Countries
(Unit: billion US$)

Note: Current prices.
Source: National Account, 1996, Bank of Korea.

4.4 Industrial Structure

The Republic of Korea has experienced rapid economic growth as well as dynamic change in its industry structure. The most remarkable changes have been declines in agriculture, forestry, fishing and mining industries, stable growth in manufacturing and the emergence of service industries. As productivities of agriculture, forestry and fishing industries stagnated during 1990-1995, their share of GDP decreased from 8.7% in 1990 to 6.6% in 1995.

The manufacturing sector maintained stable annual growth of 8.0% on average between 1990-1995, while its share in GDP remained below 30%. Growth of the manufacturing sector relied on the expansion of heavy and chemical industries, which accounted for 74% of total value-added of the manufacturing sector in 1995. On the other hand, the share of light industry was 26% of the total manufacturing sector in 1995 and has been decreasing continuously. The service sector achieved an annual average growth rate of 9.0% during 1990-1995, the highest growth rate in the private sector, and its share of GDP has remained around 50% since 1990.

Note: Based on current price GDP.
Source: National Account, 1996, Bank of Korea.

Regarding industry structure, the shares of agriculture, forestry and fishing industries and manufacturing are higher than those of most other advanced countries, while the share of the service sector is lower.

	Agriculture, Forestry and Fishing	Mining and Manufacturing			Service Sector	Manufacturing Structure	
		Mining	Manufacturing	Construct-ion, Electricity, Gas, and Water		Light Industry	Heavy and Chemical Industry
1970	26.6	1.5	21.0	6.6	44.2	60.8	39.2
1975	24.9	1.6	25.9	5.9	41.7	52.1	47.9
1980	14.7	1.5	28.2	10.1	45.5	46.4	53.6
1985	12.5	1.2	29.3	10.6	46.5	41.5	58.5
1990	8.7	0.6	29.2	13.7	47.7	34.1	65.9
1992	7.4	0.4	27.8	15.9	49.7	30.6	69.4
1994	7.0	0.4	26.9	15.8	50.7	26.9	73.1
1995	6.6	0.3	26.9	16.3	50.3	26.1	73.9

< Table 1-16 > Industry Structure

(Unit : %)

Source: International Statistics Yearbook, 1997, National Statistical Office.

4.5 Employment Structure

	Agriculture, forestry and fishing	Mining and Manufacturing		Service
			Manufacturing	
Korea(1995)	7	43	27	50
Japan(1993)	6	47	36	47
Canada(1993)	4	36	23	59
U.S.A.(1993)	2	23	18	76
France(1993)	2	30	N.A.	67
Germany(1993)	1	34	25	65
Italy(1993)	3	32	N.A.	65
United Kingdom(1992)	2	33	22	65
Australia(1992)	3	29	15	67

< Table 1-17 > Industry Structures of Major Countries

(Unit :%)

	Agriculture, Forestry and Fishing	Mining and Manufacturing		Serviced and Others
			Manufacturing	
1970	50.4	14.3	13.2	35.3
1975	45.7	19.1	18.6	35.2
1980	34.0	22.5	21.6	43.5
1985	24.9	24.4	23.4	50.6
1990	17.9	27.6	27.2	54.5
1992	15.8	25.8	25.5	58.4
1994	13.6	23.9	23.7	62.5
1995	12.5	23.5	23.4	64.0

< Table 1-18 > Employment Structure

(Unit : %)

Korea's employment structure has changed with rapid industrialization. The total number of employees in agriculture, forestry and fishing has declined from 50.4% in 1970, reaching 12.5% of the total number of employees in all sectors in 1995. The share of employment in the manufacturing sector grew from 13.2% to 23.4% over the same period. Those employed in social overhead capital and other service industries increased significantly, from 35.3% in

1970 to 64% in 1995. This rapid change is attributed to the shift in industry structure from primary industry to secondary and tertiary industries within a short period.

Note: Construction, electricity,gas, and water included.
Source: Korea's Major Economic Indicators, 1996, National Statistical Office.

As far as industry employment structure is concerned, Korea had 12.5% of total employment devoted to agriculture, forestry and fishing in 1995, which was noticeably higher than in other developed countries.

Source: International Statistical Yearbook, 1997, National Statistical Office.

	Agriculture, Forestry and Fishing	Mining and Manufacturing		Services and Others
			Manufacturing	
Korea(1995)	12.5	23.5	23.4	64.0
Japan(1995)	5.7	22.6	22.5	71.7
U.S.A. (1995)	2.9	16.9	16.4	80.2
Canada(1995)	4.1	16.5	15.3	79.4
Italy(1994)	7.9	24.2	22.7	67.9
Germany(1994)	3.3	27.5	26.7	69.2
France(1994)	4.7	19.2	18.8	76.1
Australia(1994)	5.0	15.0	14.0	80.0

< Table 1-19 > Employment Structures of Major Countries
(Unit : %)

5. Transportation

5.1 Volume of Transportation

5.1.1 Passenger Transportation

Passenger transportation in the ROK can be characterized by large increases in subways and in civil aviation, moderate increases in railroad and road, and stagnation in maritime transportation. In particular, the sharp growth in civil aviation due to rising per capita income is noteworthy. The increase in the number of passengers using subways reflects that subways are becoming more popular in urban areas than buses as the main mode of transportation. Of total passenger transportation, the share of roads has decreased steadily while that of subways has increased, since bus transportation has been replaced by subway transportation. However, road transportation still carried the largest number of passengers among all modes of transportation. The share of roads in terms of passenger- kilometers is also the highest. But the share of roads in terms of passenger-kilometers is relatively lower than that of the number of passengers transported because the travel distance on roads is shorter than that of railroads and civil aviation.

Source: Construction and Transportation Statistical Yearbook, each year, Ministry of Construction and Transportation.

5.1.2 Freight Transportation

	Passenger Total	Railway	Subway	Road	Shipping	Civil Aviation	Passenger Total	Railway	Subway	Road	Shipping	Civil Aviation
	Passengers carried in millions						Passenger-km in millions					
1975	4804	221	34	4543	6	1	52686	12926	343	38865	252	300
1980	8,545	404	65	8,039	9	1	87,626	21,640	926	64,131	401	528
1985	11,441	503	325	10,601	9	3	106,849	22,595	4,477	78,025	570	1,182
1990	14,487	645	1,102	12,722	8	11	135,336	29,864	11,229	89,712	520	4,011
1995	13,559	790	1,450	11,290	9	21	123,572	29,292	14,048	72,324	502	7,406
1996	13,803	820	1,471	11,480	9	24	124,145	29,580	72,871	72,871	547	8,288

< Table 1-20 > Trends in Domestic Passenger Transportation

The trend in freight transportation can be characterized by sharp increases in maritime

shipping, moderate increases in road transportation and stagnation in railroad transportation. The tonnage carried by vessels increased to 141 million tons in 1996 from 12 million in 1975, a ten-fold increase.

Maritime freight transportation has been facilitated by the easy access to seawaterways as the ROK is a peninsula surrounded by coastal areas. Maritime freight transportation is 46,452 million ton-kilometers, amounting to a 59% share.

The stagnation of railroad freight transportation resulted from the increase in road freight transportation. The share of railroads in freight transportation is declining as that of roads grows.

Source: Construction and Transportation Statistical Yearbook, each year, Ministry of Construction and Transportation.

	Freight Total	Railway	Road	Shipping	Civil Aviation	Freight Total	Railway	Road	Shipping	Civil Aviation
	Tonnage carried in millions					million ton-km				
1975	139	43	85	12	-	17,872	9,293	3,845	4,732	2.5
1980	173	49	105	19	-	23,186	10,798	4,920	7,463	5.1
1985	238	55	149	34	-	31,029	12,296	7,068	11,639	26
1990	337	58	215	64	-	44,187	13,663	9,325	21,127	72
1995	595	57	408	129	-	76,110	13,838	18,213	43,936	123
1996	621	54	426	141	-	78,647	12,947	19,114	46,452	134

< Table 1-21 > Trends in Domestic Freight Transportation

5.2 Means of Transportation

The high level of both economic and income growth was followed by the increasin transportation demand. The number of passenger cars has soared by 75 fold, from 127,000 in 1970 to 9.553 million in 1996.

	Passenger Cars	Buses	Trucks	Special Cars	Total
1970	60	15	48	1	127
1975	84	21	82	5	194
1980	249	42	226	9	528
1985	556	128	412	16	1,113
1990	2,074	383	924	11	3,395
1992	3,461	483	1,261	25	5,231
1994	5,148	582	1,644	29	7,404
1995	6,006	612	1,816	33	8,469
1996	6,893	663	1,962	34	9,553

< Table 1-22 > Number of Registered Motor Vehicles
(Unit: thousand)

Source: Construction and Transportation Statistical Yearbook, each year, Ministry of Construction and Transportation.

Among passenger cars for private, government and commercial use, the number of private passenger cars has increased drastically. The number has grown steadily from 29,000 in 1970 to 179,000 in 1980, and began to increase rapidly from 1985 to reach 6,653,000 in 1996. The number of persons per private passenger car has decreased from 1,069 in 1970 to 213 in 1980, to 23 in 1990 and to less than seven in 1996.

	Year	Cars per Thousand Persons
Korea	1994	165
Japan	1994	520
Canada	1994	629
Mexico	1992	131
USA	1993	748
France	1994	517
Italy	1991	541
United Kingdom	1993	403
Australia	1993	574

< Table 1-23 > Automobile Ownership in Major Countries

Source: International Statistics Yearbook, 1997, National Statistical Office.

Source: Construction and Transportation Statistical Yearbook, each year, Ministry of Construction and Transportation.

	1970	1975	1980	1985	1990	1995	1996
Number of Private Passenger Cars (thousand)	29	50	179	449	1,902	5,778	6,653
Number of Persons per Car	1,095	704	213	91	23	7.8	6.7

< Table 1-24 > Number of Private Passenger Cars and Persons per Car

2 Energy Consumption

1. Overview

Korea's energy consumption has increased sharply since the mid-1970s due to rapid economic growth focused on heavy and chemical industries. Primary energy consumption increased 7.8% annually from 1981 to 1990, and 10.0% annually from 1991 to 1996. Thus, primary energy consumption grew to 165.209 millionTOE in 1996 from 43.911 million TOE in 1980.

Per capita energy consumption has also risen as personal income surged thanks to economic growth. Per capita energy consumption has been increasing especially, rapidly since the late 1980s. It reached to 3.63 TOE in 1996 from 1.15 TOE in 1980.

As a result Korea's dependency on foreign energy continues to increase. The dependency rate on imported energy (including nuclear power) rose from 73.5% in 1980, to 87.9% in 1990, and to 97.8% in 1996. Imported energy is currently meeting nearlyall domestic energy demands. This trend is attributed to the factthat demand for high-quality energies such as petroleum and natural gas has risen while production of domestic anthracite coal has fallen sharply.

The energy/GDP ratio, which fell in the late 1980s, began to rise again from 1989. The ratio rose from about 0.5 between 1986 and 1989 to 0.6 in 1996, which is close to the 1980 level. This hike is explained by the fact that the economy depends largely on energy-intensive industries, especially heavy and chemical industries. On the other hand, the energy/GDP elasticity trend in the reverse

Source: Yearbook of Energy Statistics, 1997, KEEI.

of the energy /GDP ratio. The elasticity, which rose in late 1980s, declined in the 1990s.

		1980	1985	1990	1994	1995	1996	AAGR (%)	
								81 -90	91 -96
Energy Consumption (1,000 TOE)	Primary	43,911	56,296	93,192	137,235	150,437	165,209	7.8	10.0
	Final	37,597	46,998	75,107	112,206	121,850	132,033	7.2	9.8
Per Capita Energy Consumption (TOE/Person)		1.15	1.38	2.17	3.09	3.35	3.63	7.2	8.9
Dependency on Imported Energy (%)	Nuclear included	73.5	76.2	87.9	96.4	96.8	97.8		
	Nuclear excluded	71.6	68.8	73.7	85.7	85.6	86.1		
Share of Petroleum in Primary Energy Consumption		61.1	48.2	53.8	62.9	62.5	60.5		
Share of Electricity in Final Energy Consumption		7.5	9.3	10.8	11.2	11.5	11.9		
Energy Price Index		71.7	141.0	100.0	115.54	121.4	137.9		
Energy/GDP Ratio (TOE/Million Won)		0.58	0.51	0.52	0.58	0.58	0.60		
Economic Growth Rate(%)		-2.7	6.5	9.5	8.4	8.7	6.9	9.4	7.4
Growth Rate of Primary Energy Consumption(%)		1.5	5.4	14.1	8.1	9.6	9.8		
Energy Elasticity		-	0.83	1.48	0.96	1.10	1.41		

< Table 2-1 > Major Energy/Economic Indicators

Comparing Korea's energy/economic indicators with major developed countries, Korea's economic growth rate and energy consumption growth rate, 8.9% and 9.6% in 1995, respectively, were much higher than OECD countries' 1.9% and 1.6 % in 1995. Such a high energy consumption growth in Korea, which is still in the development stage, is the result of its high economic growth. However, per capita energy consumption in Korea is lower than the average per capita energy consumption in OECD countries.

Sources: Energy Balances of OECD Countries, 1997, OECD. International Financial Statistics, 1997, IMF.

	Korea		USA		Japan		OECD	
	1990	1995	1990	1995	1990	1995	1990	1995
Economic Growth Rate (%)	9.5	8.9	0.8	2.0	4.8	0.9	2.7	1.9
Energy Consumption Growth Rate (%)	14.1	9.6	0.1	1.6	3.4	3.9	0.2	1.6
Energy/GDP Ratio (TOE/US$1000)	0.3	0.4	0.3	0.3	0.1	0.1	0.2	0.2
Per Capita Energy Consumption (TOE/Person)	2.1	3.3	7.7	7.8	3.4	3.9	4.2	4.3

< Table 2-2 > Energy/Economic Indicators of Major Countries

With respect to electricity consumption, per capita electricity consumption in Korea, 4,006

kWh/person in 1995, was far lowerthan those of developed countries in the same year.

Source: Energy Balances of OECD Countries, 1997, OECD.
BP Statistical Review of World Energy, 1997. Yearbook of Energy Statistics, 1997, KEEI.

Source: Dynamic Forces in Capitalist Development, AngusMadison.BP Statistical Review of World Energy, 1997. Yearbook of Energy Statistics, 1997, KEEI.

	Korea		USA		Japan		UK	
	1990	1995	1990	1995	1990	1995	1990	1995
Per Capita Electricity Consumption (kWh/Person)	2,002	4,006	11,210	11,160	5,300	5,910	4,940	4,880

< Table 2-3 > Per Capita Electricity Consumption in Major Countries

Source: Dynamic Forces in Capitalist Development, AngusMadison.BP Statistical Review of World Energy, 1997. Yearbook of Energy Statistics, 1997, KEEI.

	1913	1950	1973	1990	1996
USA	436.5	866.0	1759.4	1930.7	2130.3
Japan	21.7	44.9	338.9	428.1	501.8
Germany	93.8	93.9	266.2	351.8	345.0
France	55.7	64.6	179.9	220.9	243.4
UK	157.5	158.3	220.8	213.3	230.1
Korea	N.A.	N.A.	25.0	93.2	165.1

< Table 2-4 > Energy Consumption of Major Countries

(Unit : Million TOE)

	1914-1950	1951-1973	1974-1990	1991-1996
USA	1.87	3.13	0.55	1.65
Japan	1.98	9.19	1.38	2.68
Germany	0.00	4.63	1.65	-0.32
France	0.40	4.50	1.22	1.63
UK	0.01	1.46	-0.20	1.27
Korea	NA	NA	8.05	10.01

< Table 2-5 > Annual Average Growth Rate of Energy Consumption in Major Countries

(Unit : %)

2. Energy Consumption by Source

In addition to rapid energy consumption growth, Korea has experienced significant changes in energy consumption structure since 1980.Theses changes can be summarized as the emergence of clean energy such as nuclear power and LNG, the decline of domestic coal, and the stable growth of petroleum. As a result, the shares of nuclear and LNG in total energy consumption jumped while that of coal plummeted. Petroleum consumption has maintained its share of around 60% in total primary energy.

Oil consumption increasedfrom 182.105 million Bbl in 1980 to 721.063 million Bbl in 1996, which is twice the 1990 level. This increase was partly the result of the substitution of oil for coal. The expansion of petro-chemical facilities especially accelerated oil consumption in the 1990s.

Note : Share in parentheses. Source: Yearbook of Energy Statistics, 1997, KEEI.

The share of coal in primary energy consumption, 30.1% in 1980, rapidly decreased to

	1980	1985	1990	1994	1995	1996	AAGR (%)	
							81-90	91-96
Petroleum (kBBL)	182,105 (61.1)	189,191 (48.2)	356,349 (53.8)	621,498 (62.9)	677,209 (62.5)	721,063 (60.5)	6.9	12.4
Coal (kTon)	25,862 (30.1)	40,533 (39.1)	43,405 (26.2)	42,660 (19.4)	44,352 (18.7)	50,277 (19.7)	5.3	2.4
LNG (kTon)	- (0.0)	- (0.0)	2,329 (3.2)	5,860 (5.6)	7,087 (6.1)	9,361 (7.4)	-	26.1
Hydro Power (GWh)	1,984 (1.1)	3,659 (!.6)	6,361 (1.7)	4,098 (0.7)	5,478 (0.9)	5,201 (0.8)	12.4	-3.2
Nuclear Power (GWh)	3,477 (2.0)	16,745 (7.4)	52,887 (14..2)	58,651 (10.7)	67,029 (11.1)	73,924 (11.2)	31.3	5.7
Misc. (kTOE)	2,492 (5.7)	2,031 (3.6)	797 (0.9)	742 (0.7)	1,051 (0.7)	1,161 (0.7)	-10.8	6.5
Total (kTOE)	43,911 (100.0)	56,296 (100.0)	93,192 (100.0)	137,235 (100.0)	150,437 (100.0)	165,209 (100.0)	7.8	10.0

< Table 2-6 > Trend in Primary Energy Consumption

26.2% in 1990 and fell to 19.7% in 1996, although coal consumption grew 2.4% between 1991 and 1996. In fact, domestic anthracite consumption declined dramatically due to the

"rationalization of coal industry" policy in response to mounting environmental concerns and high cost in domestic coal production. Only imported bituminous coal consumption was increased, owing to the demand mainly from steel and electricity industries.

As a clean energy source, LNG consumption in Korea exploded since 1986 when LNG was first introduced. LNG consumption increased 177-fold in 11 years, reaching 9,361 thousand tons in 1996 from 53 thousand tons in 1986. LNG accounted for 7.4% of total primary energy consumption in 1996. Its meteoric rise is attributed to the government's policy to encourage LNG consumption, reducing the nation's heavy reliance on petroleum and diversify energy sources and also to consumers' preference for cleaner energy. The Korean Government has undertaken consistent construction of infrastructure for LNG supply, such as receiving terminals and a national pipeline network, to meet the ever-increasing demand.

Nuclear power, another clean energy source introduced in 1978, also has exhibited significant growth. Its consumption increased at an annual rate of 31.3% in the 1980s. Nuclear power generation, 73,924GWh in 1996, accounted for 11.2 % of total primary energy consumption.

Korea's dependency rate on fossil fuels was 87.3% in 1995, slightly higher than average OECD levels.

Source : BP Statistical Review of World Energy, 1997.

3. Energy Consumption by Sector

	Korea		USA		Japan		OECD	
	1990	1995	1990	1995	1990	1995	1990	1995
Petroleum	53.8	62.5	39.9	39.0	58.9	54.6	42.1	43.0
Natural Gas	3.2	6.1	23.1	27.0	10.0	11.2	20.0	22.6
Coal	26.2	18.7	27.4	23.9	17.1	17.5	22.4	20.7
Nuclear Power	14.2	11.1	8.4	8.8	12.2	15.1	9.1	11.2
Hydro Power	1.7	0.9	1.2	1.2	1.8	1.5	6.4	2.5
Reliance on Fossil Fuels	83.2	87.3	90.4	89.9	86.0	83.3	84.5	86.3

< Table 2-7 > Energy Consumption Structures in Major Countries

(Unit : %)

Sectoral energy consumption in Korea since the 1980s can be characterized by rapid increases in the industry and transportation sectors and slow or even negative growth in the

commercial/residential and public sectors. As a result of these changes in the sectoral energy consumption, the shares of the industry and transportation sectors in final energy consumption reached 51.4% and 22.6% in 1996 from 44.1% and 13% in 1980 respectively. Meanwhile, the share of the commercial/residential and public sectors shrank from 37.3% and 5.6% to 24.0% and 2.0%, respectively, during the same period.

Note: Shares in the parentheses.
Source: Yearbook of Energy Statistics, 1997, KEEI.

3.1. Industrial Sector

As economic growth has been led by the industry sector, so has energy consumption. Energy consumption in the industrial sector increased from 16.571 million TOE in 1980 to

	1980	1985	1990	1994	1995	1996	AAGR (%)	
							81-90	91-96
Industry	16,571 (44.1)	20,014 (42.6)	36,151 (46.2)	59,909 (53.4)	62,946 (51.6)	67,869 (51.4)	8.1	13.4
Transportation	4,905 (13.0)	6,707 (14.3)	14,173 (17.6)	23,860 (21.3)	27,148 (22.3)	29,792 (22.6)	11.2	13.2
Residential and Commercial	14,034 (37.3)	18,180 (38.7)	21,971 (32.3)	25,968 (23.1)	29,339 (24.1)	31,713 (24.0)	4.6	6.3
Public and Other	2,087 (5.6)	2,096 (4.5)	2,812 (4.6)	2,469 (2.2)	2,416 (2.0)	2,659 (2.0)	3.0	-0.9
Total	37,597 (100.0)	46,998 (100.0)	75,107 (100.0)	112,206 (100.0)	121,850 (100.0)	132,033 (100.0)	7.2	9.9

< Table 2-8 > Trend of Final Energy Consumption by Sector

(Unit : kTOE, %)

36.151 million TOE in 1990 (2.2 times), to 67.869 million TOE in 1996 (1.9 times the 1990 level), which accounted for 51.4% of the total final energy consumption.

Regarding energy consumption in the industrial sector, petroleum's share was significant at 57.4%, followed by coal at 25.0 % and electricity at 13.5%. As anthracite coal consumption has almost completely ceased, bituminous coal has been mainly consumed to meet the demand in steel and power generation industries. Coal consumption grew from 22.0% in 1980, 29.9% in 1990 and then fell to 25.0% in 1996,

Note: Shares in parentheses.
Source: Yearbook of Energy Statistics, 1997, KEEI.

3.2 Transport Sector

Energy consumption in the transport sector showed a marked increase compared to other sectors. It was only 4.905 million TOE in 1980, but increased to 14.173 million TOE in 1990 and to 29.792 million TOE in 1996 (2.1 times the 1990 level). Thus, the share of transport sector in final energy consumption rose from 13.0% in 1980 to 17.6% in 1990 and

	1980	1985	1990	1994	1995	1996	AAGR (%)	
							81-90	91-96
Petroleum	10,948 (66.0)	10,697 (53.4)	20,014 (55.4)	35,881 (64.5)	36,810 (58.5)	38,913 (57.4)	6.2	13.0
Coal	3,653 (22.0)	6,491 (32.4)	10,807 (29.9)	15,403 (27.7)	16,244 (25.8)	17,669 (25.0)	11.5	8.5
Electricity	1,971 (12.0)	2,812 (14.0)	5,095 (14.1)	7,398 (13.3)	8,293 (13.2)	9,179 (13.5)	10.0	10.2
City Gas	0.0 (0.0)	15.0 (0.1)	235 (0.7)	601 (1.1)	863 (1.4)	1,196 (1.8)	-	29.7
Others	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	626 (1.1)	763 (1.2)	912 (1.3)	-	-
Total	16,571 (100.0)	20,015 (100.0)	36,151 (100.0)	55,591 (100.0)	62,946 (100.0)	67,869 (100.0)	8.1	11.7

< Table 2-9 > Trend of Energy Consumption by Source in Industrial Sector

(Unit : thousand TOE, %)

to 22.6% in 1996.

Although such increases were brought about by factors in all transportation modes, the leading factor was the sharp increase of gasoline consumption caused by private passenger car expansion. Gasoline consumption, which was 759 thousand TOE in 1980, increased to 2.936 million TOE in 1990 and to 8.664 million TOE, or 30.8% of energy consumption in the transportation sector, in 1996.

Note: Shares in the parentheses.
Source : Yearbook of Energy Statistics, 1997, KEEI.

3.3. Residential and Commercial Sectors

Energy consumption in the residential and commercial sector grew moderately from 1980 to 1996 compared to those of other sectors like industry and transportation. It increased from 14.034 million TOE in 1980 to 21.973 million TOE in 1990 and to 31.713

	1980	1985	1990	1994	1995	1996	AAGR (%)	
							81-90	91-96
Petroleum	4,869 (99.3)	6,645 (99.1)	14,086 (99.4)	23,736 (99.5)	27,010 (99.5)	29,647 (99.5)	11.2	13.2
Gasoline	759 (16.7)	754 (11.3)	2,936 (20.8)	6,451 (27.2)	7,527 (27.9)	8,664 (30.8)	12.2	23.9
Electricity	34 (0.7)	62 (0.9)	87 (0.6)	124 (0.5)	138 (0.5)	145 (0.5)	9.9	8.9
Total	4,905 (100.0)	6,707 (100.0)	14,173 (100.0)	23,860 (100.0)	27,148 (100.0)	29,792 (100.0)	11.2	13.2

< Table 2-10 > Trend of Energy Consumption by Source in Transport Sector
(Unit : kTOE, %)

million TOE in 1996 (1.4 times the 1990 level). Hence, the share of the residential and commercial sector in final energy consumption fell significantly from 37.3% in 1980 to 24.0% in 1996.

One of the most dramatic changes in energy consumption patterns since the late 1970s can be seen in the residential and commercial sector. Coal, once the main source of energy, accounting for 61.8% of energy demand in the sector in 1980, became the least important source with 3.3% share in 1996. The shares of oil, gas, and electricity consumption rose from 15.8%, 0.1%, and 4.4% to 58.7%, 17.6%, and 17.2%, respectively, during the same period.

Such changes came from persistent inter-fuel substitution with the increased availability of more convenient fuels like petroleum and gas in the residential sector and also from government regulations to limit coal consumption in urban areas to reduce air pollution. The consumption of petroleum increased from 2.222 million TOE in 1980 to 8.879 million TOE

in 1990 and to 18.623 million TOE in 1996. In contrast, coal consumption increased from 8.670 million TOE in 1980 to 9.027 million TOE in 1990 and then decreased to 1.050 million TOE in 1996.

Note: Shares in parentheses.
Source: Yearbook of Energy Statistics, 1997, KEEI.

The increase in electricity demand was caused by the rapid dissemination of household appliances and home electronics products. Color TVs and refrigerators numbered more than one per household by the end of the1980s, and washing machines numbered almost one per household by the mid-1990s.

The number of air conditioners steadily increased from 0.09 per household in 1993 to 0.13 per household in 1995, while PCs grew from 0.32 per household in 1993 to 0.61 in 1995

	1980	1985	1990	1994	1995	1996	AAGR (%)	
							81-90	91-96
Petroleum	2,222 (15.8)	3,525 (19.4)	8,879 (40.4)	15,375 (59.2)	17,632 (60.01)	18,623 (58.7)	14.3	13.1
Coal	8,670 (61.8)	11,400 (62.7)	9,027 (41.1)	2,267 (8.7)	1,514 (5.2)	1,050 (3.3)	0.4	-30.1
Electricity	611 (4.4)	1,155 (6.4)	2,421 (11.0)	4,321 (16.6)	4,801 (16.4)	5,464 (17.2)	14.8	14.5
City Gas	15 (0.1)	69 (0.4)	777 (3.5)	3,313 (12.8)	4,495 (15.3)	5,588 (17.6)	48.4	38.9
Thermal Energy	0.0 (0.0)	0.0 (0.0)	75 (0.3)	454 (1.7)	632 (2.2)	796 (2.5)	-	48.2
Others	2,517 (17.9)	2,031 (11.2)	797 (3.6)	238 (0.9)	265 (0.9)	192 (0.6)	-10.9	-21.1
Total	14,034 (100.0)	18,180 (100.0)	21,973 (100.0)	25,968 (100.0)	29,339 (100.0)	31,713 (100.0)	4.6	6.3

< Table 2-11 > Trend of Energy Consumption in Residential/Commercial Sector

(Units : TOE, %)

(doubling in two years).

Source: Study on Penetration Rate of Appliances, 1996, KEPCO.

3.4. Public and Other Sectors

	1989	1991	1993	1995
Color TV	104	127	135	137
Refrigerator	103	110	108	105
Washing Machine	65	86	91	96
Air Conditioner	9	8	9	13
PC	4	11	32	61

< Table 2-12 > Per Household Ownership Rate of Major Appliances
(Unit : %)

Energy consumption in public and other sectors, which showed a moderate increase in the 1980s, began to decrease in the 1990s. Energy consumption in these sectors increased from 2.087 million TOE in 1980 to 2.812 million TOE in 1990, then decreased to 2.659 million TOE in 1996.

Among energy sources, coal and petroleum consumption decreased while gas and electricity consumption increased. Petroleum consumption, which accounted for 85.6% of total energy consumption in these sectors in 1980 and 80.9% in 1990, fell to 1.530 million TOE in 1996, only 57.6% of total consumption. Electricity consumption was 904 thousand TOE in 1996 (33.9%), a relatively high increase from 9.5% in 1985 and 18.3% in 1990. Gas consumption has also steadily increased, reaching 153 thousand TOE in 1996, and the trend is projected to continue.

4. Power Generation

Power generation in Korea has increased tremendously over the past two decades. At the same time, it has undergone structural changes to meet increasing demand for electricity resulting from economic and income growth. Power generation rose from 37,238 GWh in 1980 to 205,493 GWh in 1996. Meanwhile, nuclear and LNG power generation surged replacing oil-fired plants which played a major role in the 1980s.

Note: Shares in the parentheses.
Source: Yearbook of Energy Statistics, each year, KEEI.

	1980	1985	1990	1994	1995	1996	AAGR (%)	
							81-90	91-96
Total Power Generation (GWh)	37,238	58,007	107,669	164,992	184,660	205,493	11.2	11.3
- Nuclear	3,477 (9.3)	16,745 (28.9)	52,887 (49.1)	58,651 (35.5)	67,029 (36.3)	73,924 (36.0)	31.3	5.7
- Coal	2,481 (6.7)	17,639 (30.4)	19,961 (18.5)	41,835 (25.4)	48,813 (26.4)	56,881 (27.6)	23.2	19.1
- LNG	- -	- -	9,604 (8.9)	20,046 (12.1)	21,296 (11.5)	27,050 (13.2)		18.8
- Petroleum	29,297 (78.7)	19,964 (34.5)	18,856 (17.6)	40,313 (24.5	42,045 (22.8)	42,436 (20.7)	-4.3	14.5
- Hydro	1,984 (5.3)	3,659 (6.3)	6,361 (5.9)	4,098 (2.5)	5,478 (3.0)	5,201 (2.5)	12.4	-3.2
Generation Facilities (MW)	9,390	16,136	21,021	28,749	32,183	35,715	8.4	9.2
Transmission and Distribution Loss (%)	6.6	5.89	5.62	5.59	5.46	5.40	-	-

< Table 2-13 > Major Indicators in Power Generation Sector

Since 1978, when the first nuclear power plant began its commercial operation, nuclear power generation has increased more than 21.1% per annum. Between 1981 and 1990, the growth rate was 31.3%, accounting for more than half of the total electricity consumed in 1987.

Such expansion of nuclear power generation capacity reduced the share of thermal power generation capacity. The share of oil-fired thermal power generation has plummeted from

78.7% in 1980 to 20.7% in 1996. LNG-fired power generation, introduced in 1986, increased to 13.2% of total generation in ten years.

Such trends show that the Korean Government has taken significant steps to expand nuclear and LNG power generation capacity to ease environmental problems from fossil fuel use. Other achievements like thermal efficiency improvement and reduction of transmission and distribution losses also helped ease environmental problems.

Sources: 1. Energy Balances of OECD Countries, 1993-1994, 1997.
2. Business Statistics, 1997, KEPCO.

Source: Business Statistics, 1997, KEPCO.

	Korea		USA		Japan		UK	
	1990	1995	1990	1995	1990	1995	1990	1995
Nuclear	49.1	36.3	19.2	20.1	23.8	26.7	20.7	26.7
Coal	18.5	26.4	53.4	51.5	14.5	17.8	65.1	43.0
LNG	8.9	11.5	12.0	14.9	19.5	19.5	1.1	17.5
Petroleum	17.5	22.8	4.1	2.5	31.6	22.8	10.8	10.6
Hydro	5.9	3.0	8.5	8.8	10.5	8.4	1.6	1.6

< Table 2-14 > Power Generation Mix in Major Countries
(Based on Generation Levels)

(Unit : %)

	Korea		USA		Japan		UK	
	1990	1995	1990	1995	1990	1995	1990	1995
Efficiency in Thermal Power Plants	34.9	38.1	32.9	32.7	37.1	37.2	33.7	35.7
Losses in Transmission and Distribution	5.6	5.4	5.7	5.4	5.7	5.5	8.1	8.0

< Table 2-15 > International Comparison of Power Generation Efficiency and Transmission and Distribution Losses

(Unit : %)

3 Inventory of Greenhouse Gas Emissions and Removals

This inventory of greenhouse gas emissions and removals in Korea is based on IPCC guidelines[1] with a base year of 1990. It covers direct greenhouse gases (CO_2, CH_4, and N_2O) as well as indirect greenhouse gases (NOx, CO, and NMVOC). This chapter provides annual estimates of CO_2 emissions fromfossil fuel combustion between 1991 and 1995.

1. Methods for Inventories

1.1 Overview

The emissions and removals of greenhouse gases presented herein are based on "IPCC Guidelines for National Greenhouse Gas Inventories" (UNEP/OECD/IEA/IPCC, 1995). However, a non-IPCC methodology was used to calculate methane emissions from rice fields and livestock in the agriculture sector. Emissions from international activities including air and marine transportation are listed separately as "international bunkering."

1.2 Greenhouse Gas Coverage and Base Year

Six greenhouse gases are covered: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), nitrogen oxides (NOx), carbon monoxide (CO), and non-methane volatile organic compounds (NMVOCs). Non-CO_2 greenhouse gasemissions in the energy-related sector are calculated based on 1989 census data. CO_2 emissions from fossil fuel combustion are provided for the period between 1991 and 1995.

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[1]) However, in some cases, an inventory methodology was applied different from that is recommended in IPCC Guidelines. An explanation for the difference in methodologies is given where appropriate.

1.3 Classification of Sectors

The major sectors to be addressed are the energy, industrial processes, agriculture, waste management, forestry, and land use sectors. For each sector inventories of CO_2, CH_4, N_2O, and other gases are separately listed as well as CO_2 sinks. The energy sector consists of combustion and non-combustion sub-sectors.

1.4. International Bunkering and Biomass

International bunkering is reported separately and not included in domestic totals. CO_2 emissions from biomass are assumed to be zero in accordance with the sustainable growth assumption.

1.5 Accuracy of Emissions Data

The reliability of the emissions inventory depends on input statistics and inventory methodologies. When input statistics are insufficient or emission factors are not suitable for existing data, the reliability is somewhat degraded.

The CO_2 emissions inventory from energy consumption is relatively reliable as energy consumption data has been well established since the end of the 1960's. Its reliability has been enhanced by the 1978 establishment of the Ministry of Energy and Resources, which is now a part of the Ministry of Trade, Industry and Energy.

Korea's Yearbook of Energy Statistics is the major source of data. It records not only the amount of energy consumption by sector but also the electricity sector by source. However, detailed, industry specific data on end-user energy consumption is not available nor is data on energy consumption by type of appliance and equipment.

The non-CO_2 emissions inventory from energy consumption is not as reliable as other statistics because IPCC emission factors are not suitable for the currently available data. To apply the IPCC non-CO_2 emission factors requires final energy consumption data by sector as well as by end-user, but there is no data satisfying such requirements at the moment. The best available data is from Korea's "Energy Census" which has been conducted once every

three years. In order to produce the most reliable non-CO_2 emissions inventory of residential and commercial, and public sectors the data from "Energy Census, '89" has been utilized.

The reliability of the non-CO_2 emissions inventory of other sectors including agriculture, forestry, waste management and industrial processes is significantly hampered by the lack of accumulated input data. To make the emissions inventory for these sectors more reliable in the future, the Korean Government will take measures to modify ways to collect, process, and report the necessary inventory data.

2. Overview of Emissions and Removals of Greenhouse Gases

2.1 Overview of Greenhouse Gas Emissions and Removals

Table 3-1 shows greenhouse gas emissions and removals for 1990. Although it provides a full account of CO_2 and non-CO_2 emissions in the energy sector, the table does not cover a significant portion of othersectors which do not have relevant data available. For the next National Communication, the Korean Government will make efforts to refine and provide an emissions inventory forsectors which are not covered in this report.

Note: 1) non-CO emissions are those from residential and commercial sectors in 1989

Category	CO_2	CH_4	N_2O	NOx	CO	NMVOCs
Net Emissions	230,278	1,362	12	851	1,056	152
1. Energy-Related Emissions	238,990	264	11	851	1,056	152
A. Fuel Combustion	238,990	17	11	851	1,056	152
1. Energy Transformation	37,934	0.3	2	193	7	N.A.
2. Industry	87,282	1	2	135	25	N.A.
3. Transport	42,198	6	2	401	600	152
4. Residential and Commercial[1)]	64,592	7	3	105	364	N.A.
5. Public and Other[2)]	6,985	0.5	4	16	39	N.A.
6. Biomass Burning	-	2	0.02	0.6	20	N.A.
B. Fugitive Fuel Emissions	-	246	-	-	-	-
1. Coal Mining	-	230	-	-	-	-
2. Oil and Gas Systems	-	16	-	-	-	-
2. Industrial Processes	17,512	5	-	-	-	-
A. Cement Industry	14,841	-	-	-	-	-
B. Limestone and Dolomite Use	2,459	-	-	-	-	-
C. Soda Ash Use	212	-	-	-	-	-
D. Chemical Industry	-	5	-	-	-	-
3. Agriculture	-	599	1	-	-	-
A. Rice Fields	-	414	-	-	-	-
B. Enteric Fermentation	-	144	-	-	-	-
C. Animal Excrement	-	41	-	-	-	-
D. Nitrogen Fertilizers	-	-	1	-	-	-
4. Waste Management	11	495	-	-	-	-
A. Waste Incineration	11	-	-	-	-	-
B. Landfills	-	200	-	-	-	-
C. Household Wastewater	-	21	-	-	-	-
D. Industry Wastewater	-	274	-	-	-	-
5. Total	256,513					
6. Removals (Managed Forest)	-26,235	-	-	-	-	-
7. International Bunkering	7,140	-	-	-	-	-

< Table 3-1 > Greenhouse Gas Emissions/Removals in Korea (1990) (unit : Gg)

2) non-CO2 emissions are those from public and other sectors in 1989

2.2 Global Warming Potential (GWP)

Table 3-2 shows the result of GWP for direct greenhouse gas emissions with a 100-year time horizon, which was calculated in accordance with the IPCC guidelines. It indicates that CO_2 emissions have the largest share of GWP, 87.7%, followed by methane and nitrous oxide.

Source : Korea Energy Economics Institute

	Emissions(Gg)	GWP Index	GWP	Share (%)
Carbon Dioxide (CO_2)	230,278	1	230,278	87.7
Methane (CH_4)	1,362	21	28,602	10.9
Nitrous Oxide (N_2O)	12	310	3,720	1.4
Total			262,600	100.0

< Table 3-2 > GWP of direct GHGs with 100-year time horizon.

(unit: Gg-CO_2)

3. Carbon Dioxide (CO_2)

3.1. Overview

Carbon dioxide emissions are mainly from fossil fuel combustion, industrial processes and waste management, and their major sinks are forests. However, CO_2 emissions from this source are not considered as there is no significant land use change in Korea.

The net CO_2 emissions in Korea for 1990 were 230,278 Gg (equivalent to 62.8 MtC), while total emissions were 256,513 Gg and forest net removals 26,235 Gg, 10% of total emissions. International bunkering of 7,140 Gg is not included in the net emissions calculation.

3.2. Energy Sector

In 1990, CO_2 emissions from fossil fuel combustion reached 238,990Gg. The energy sector, the primary fossil fuel combustion sector, consists of industry, transport, residential and commercial, public, and energy transformation sub-sectors. The energy transformation sub-sector incorporates electric power generation. This sub-sector separately includes CO_2 emissions from electricity consumption inindustry, transport, residential and commercial and public sectors.

CO_2 emissions from fossil fuel combustion in the industry sub-sector had the largest share, accounting for 37% of total CO_2 emissions. The combined total of emissions from residential and commercial sub-sectors was the second largest with a share of 27%, followed by 18% in the transportation sub-sector, 3% in public sub-sector, and 16% in energy transformation sub-sector.

3.3. Industrial Process and Waste Management Sectors

Carbon Dioxide emissions data are not readily available for all sub-sectors, but are available for some individual industries. Cement production is the main source of CO_2 emissions, with total emissions amounting to 14,841Gg in 1990. There are two processes emitting CO_2 in cement production: one is the soda ash utilization process and the other is the limestone and dolomite utilization process. CO_2 emissions from the soda ash utilization process were 212 Gg, and those from limestone & dolomite use 2,459Gg. In addition, CO_2 emissions from waste incineration in the waste management sector were 10Gg. The next National Communication will cover more industries for the calculation of CO_2 emissions.

3.4. Removals of Carbon Dioxide

Land use change is not significant in the forestry sector in Korea and less than 10,000 ha per year has been converted to other uses. Thus, the change in greenhouse gas emissions by land use change was not calculated. As a result, the net CO_2 removals by forests are determined from differences between "total sinks from tree growth" and "total emissions from harvests."

Total carbon dioxide removals by forests in 1990 were 29,073Gg, while CO_2 emissions

by harvest were 2,838 Gg. Net CO_2 removals by forests were 26,235 Gg).

Source : Korean Forestry and Greenhouse Gases, 1996, Forestry Research Institute

3.5. Trend of $C0_2$ Emissions from Fossil Fuel Combustion (1990-1995)

Table 3.4 shows that CO_2 emissions from fossil fuel combustion increased at an annual

Categories	Annual Carbon Emissions and Removal (kTC)	Annual CO_2 Emissions and Removal (Gg)
	A	B=(A*44/12)
Emission Removal	7,929	29,073
Emission by Harvest	774	2,838
Net Removal	7,155	26,235

< Table 3-3 > Annual Carbon Dioxide Removal by Forests (1990)

rate of 9.4% from 1991-1995. For the same period, CO_2 emissions from electricity generation had the highest annual average growth rate of 17.9%. Those from transportation, industry, and residential and commercial increased annually at 13.9%, 8.8%, and 1.4%, respectively. Emissions from the public and other sectors declined at an annual average rate of 7.9% from 1991 to 1995.

Source : Korea Energy Economics Institute

	1990	1991	1992	1993	1994	1995	AAGR(%) (91-95)
Energy Sector	238,990	262,559	285,793	313,986	342,746	374,104	9.4
Energy Transformation	37,934	44,455	52,295	59,688	76,378	86,472	17.9
Industry	87,282	101,317	110,889	121,988	127,703	132,768	8.8
Transportation	42,198	48,142	55,206	62,930	71,040	80,868	13.9
Residential/Commercial	64,592	61,804	62,302	64,389	62,648	69,374	1.4
Public and Others	6,985	6,841	5,101	4,991	4,977	4,622	-7.9
International Bunkering	7,140	9,907	12,527	14,782	16,100	17,899	20.2

< Table 3-4 > Trend of CO_2 Emissions from Fossil Fuel Combustion

(unit : Gg)

4. Methane (CH_4)

Following IPCC guidelines, thesectoral methane emissions calculation takes into account the energy, agricultural, waste management, and industrial process sectors. In the energy sector, methane emissions come from fuel combustion and fugitive processes, in the agriculture sector, from rice fields and livestock, and in the waste management sector, from waste and waste-water treatment. Methane emissions also result from some chemical industry processes. The total amount of methane emissions in Korea for 1990 were 1,362 Gg. Those from the agriculture sector were 599Gg, 44% of the total, and waste management emissions were 495Gg, 36% of the total.

The largest single agricultural sub-sector emitting methane in 1990 was rice farming at 414 Gg, 30% of total emissions. Since the methane emission factors differ from region to region, it is necessary to use regional coefficients. Since 1993, the National Institute of Agricultural Science and Technology has continuously monitored and recorded methane emissions from water management, organic (straw) amendment, rice-based cropping system, and rice cultivation while the National Honam Agricultural Experiment Station and the National Yeoungnam Agricultural Experiment Station have engaged in various researches on emission mitigation methods in paddy fields since 1994. Those researches produced a set of emission factors derived from actual Korean agricultural circumstances.

When both the emission factors from IPCC Guidelines and the Korea-specific emission factors are applied, the amount of methane emissions based on the IPCC Guidelines are larger by 19% than those estimated by applying the Korean factors. Using the Korea-specific factors, the amount of methane emissions in 1990 from rice fields in Korea were 414Gg.

Methane emissions from livestock have their origins in enteric fermentation of ruminants and anaerobic decomposition of animal excrement. They also come from various sources including anaerobic decomposition of organic wastes, wastewater management, the anaerobic treatment of wastewater containing organic materials and fuel combustion processes - though the amount is not significant - when hydrocarbon in fuel is not completely burned. Methane emissions from fermentation of ruminants, animal excrement, and landfills were calculated based on IPCC guidelines.

Source : National Institute of Agricultural Science and Technology, 1995

Water Management Mode	Methane Emission Factors ($gm^{-2}d^{-1}$)		Methane Emissions (CH_4 Gg)	
	IPCC Methodology (IPCC default value)	Actual Measurement	IPCC Methodology	Measurement Inference
Continuous flooding (NPK only)	0.391-0.466	0.273	69.63	42.53
Intermittent flooding (Fall amendment of rice straw)	0.234-0.280	0.236	422.99	371.73
Total	-	-	492.62	414.26

< Table 3-5 > Methane Emissions from Rice Fields (Comparisons between IPCC Guidelines and Actual Measurement)

5. Nitrous Oxide (N_2O)

Nitrous oxide is produced from fuel combustion, use of nitrogen fertilizers, and industrial processes. Industrial processes produce nitrous oxide as a by-product in nitrous acid and adipic acid production. However, N_2O emissions from nitrous acid production are not included in this report due to the lack of data as production of nitrous acid only began in 1992.

N_2O emissions in 1990 totaled 12.4 Gg, of which 11.4 Gg came from fuel combustion, accounting for 92% of total emissions. Emissions from nitrogen fertilizers were negligible.

6. Other Greenhouse Gases

IPCC guidelines provides inventory methodologies for CO, NOx, and NMVOCs as non-CO_2 gases. These are indirect climate-related greenhouse gases affecting formulation of ozone, which, in turn, influences the lifetime of greenhouse gases, such as CO_2, CH_4, and N_2O, in the atmosphere.

Only CO, NOx, and NMVOC emissions from energy consumption were calculated. Other greenhouse gas emissions in industrial processes, agriculture and the waste management sectors could not be incorporated due to lack of data. Since the calculation of non-CO_2 emissions heavily depends on fuel type, combustion technology, vehicle type, heating technology, and boiler technology, their inventory require high precision data. The 1989 energy census data were used to calculate non-CO_2 emissions as they are the most reliable and comprehensive available.

NOx emissions from fuel combustion were 851 Gg, CO emissions 1,056 Gg, and NMVOCs emissions 152 Gg. The transport sector emitted 600 Gg of CO, more than half of the total emissions. The residential sector, with small-scale combustion facilities, emitted 364 Gg of CO, or 34% of total emissions. Due to declining coal consumption and wide use of LNG, carbon monoxide emissions from residential and commercial and public sectors are falling. Nitrogen oxide emissions in 1989 amounted to 851 Gg. The transport sector emitted the largest amount of NOx, nearly half of the total. The power and industry sectors rank as the second and third largest sources of NOx emissions. However, only transportation sector emissions were calculated and they were 152 Gg in 1989.

4 Projection of Energy Demand and CO_2 Emissions

1. Assumptions

The Rational Energy Utilization Act made it mandatory to establish a "Basic 10-Year National Energy Plan" and to revise it every fifth year to reflect changes in economic circumstances and population growth as a rolling plan. As a part of the plan, an energy demand forecast has been made and updated.

The energy demand forecast used a modified version of LEAP (Long-range Energy Alternative Program) which was developed by the TELLUS Institute in the U.S.A. The model adopts a bottom-up approach and forecasts energy consumption by sector and projects national energy demand by summing upsectoral energy consumption. The LEAP model is one of the most widely used models in the world. It is similar to other models, such as MEDEE and STAIR.

Assumptions made regarding some key variables affecting energy demand are as follows:

? Population growth is less than 1% and the population is about 49,683,000 in 2010.

? The number of households increases from 12,961,000 in 1995 to 13,967,000 in 2000 to 16,561,000 in 2010. The average number of family members decreases from 3.5 in 1995 to 3 in 2010, as the small-family trend continues.

? The gross domestic product increases from 257.5 trillion Won in 1995 (1990 constant prices) to 357.7 trillion Won in 2000 to 610.9 trillion Won in 2010.

  ? Shrinkage of agriculture, forestry, and fishing (a side-effect of Uruguay Round), but steady growth in manufacturing, and expansion of service sector.

  ? Growth of energy-intensive manufacturing industries will slow after 2000.

? Number of vehicles increases steadily from 8,469,000 in 1995 to 15,148,000 in 2000, then slows down.

  ? Number of passenger cars increases from 5,792,000 in 1995 to 11,088,000 in 2000 and to

24,297,000 in 2010.

	1995	2000	2010
GDP (1990 constant prices, trillion won)	257.5 (100)	357.7 (139)	610.9 (237)
Population	44,851,000 (100)	46,789,000 (104)	49,683,000 (111)
Number of households	12,961,000 (100)	13,967,000 (108)	16,561,000 (128)
Number of cars	8,469,000 (100)	15,148,000 (179)	30,062,000 (355)

< Table 4-1 > Projections of Economic and Social Indicators

Note: The values in parentheses are relative magnitude.1995=100.
Source: Korea Energy Economics Institute.

2. Energy Demand

A projection for energy demand in Korea is shown in < Table 4-2 >. The energy demand is expected to grow from 150.4 million TOE in 1995 to 213.4 million TOE in 2000, to 272.9 million TOE in 2005, and to 328.1 million TOE in 2010 to support economic growth. The annual average growth rate from 1996 to 2010 is projected at 5.3%.

	1985	1990	1995	2000	2005	2010	AAGR(%)	
							86-95	96-10
Primary energy demand	56.3	93.2	150.4	213.4	272.9	328.1	10.3	5.3
Final energy demand	47.0	75.1	121.9	169.9	212.6	251.2	10.0	4.9
Energy/GDP	0.51	0.52	0.58	0.60	0.58	0.54	1.5	-0.6
Per capita energy consumption	1.4	2.2	3.4	4.6	5.7	6.6	9.3	4.6

< Table 4-2 > Energy Demand Projection (unit: million TOE, TOE/90 million Won, per capita TOE)

Source: Korea Energy Economics Institute.

[Figure 4-1] Energy Demand Projection

3. CO_2 Emissions

The projected CO2 emissions are shown in < Table 4-3 >. CO2 emissions in Korea are expected to grow from 101.1 million TC in 1995 to 148.5 million TC in 2000, to 187.4 million TC in 2005, and to 217.0 million TC in 2010 as energy demand for economic growth increases. The annual average growth rate of CO2 emissions from 1996 to 2010 is projected at 5.2%.

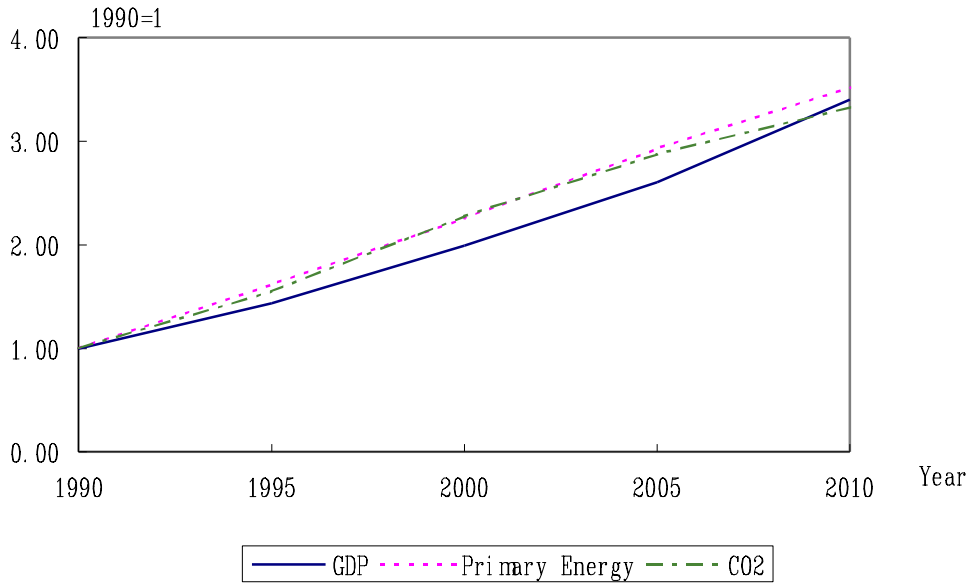
	1985	1990	1995	2000	2005	2010	AAGR(%)	
							86-95	96-10
CO2 emissions	44.0	65.2	101.1	148.5	187.4	217.0	8.7	5.2
Per capita CO2 emissions	1.1	1.5	2.3	3.2	3.9	4.4	7.7	4.5
CO2 /GDP	0.39	0.36	0.39	0.42	0.40	0.36	-0.1	-0.7

< Table 4-3 > CO2 Emissions Projection (unit: million TC, per capita TC, TC/ 90 million Won)

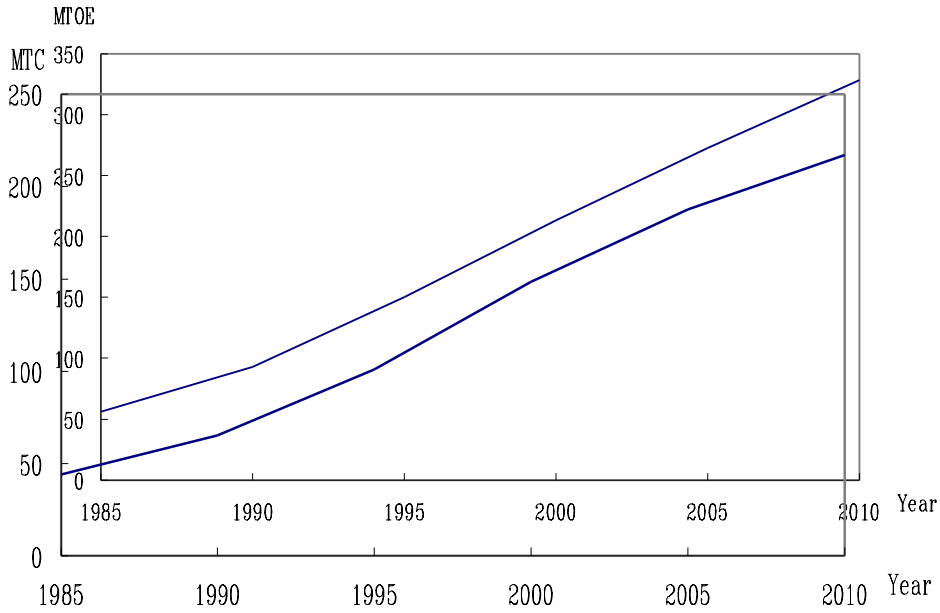
[Figure 4-2] CO2 Emissions Projections

Chapter : Summary

CO2 Emissions Projection

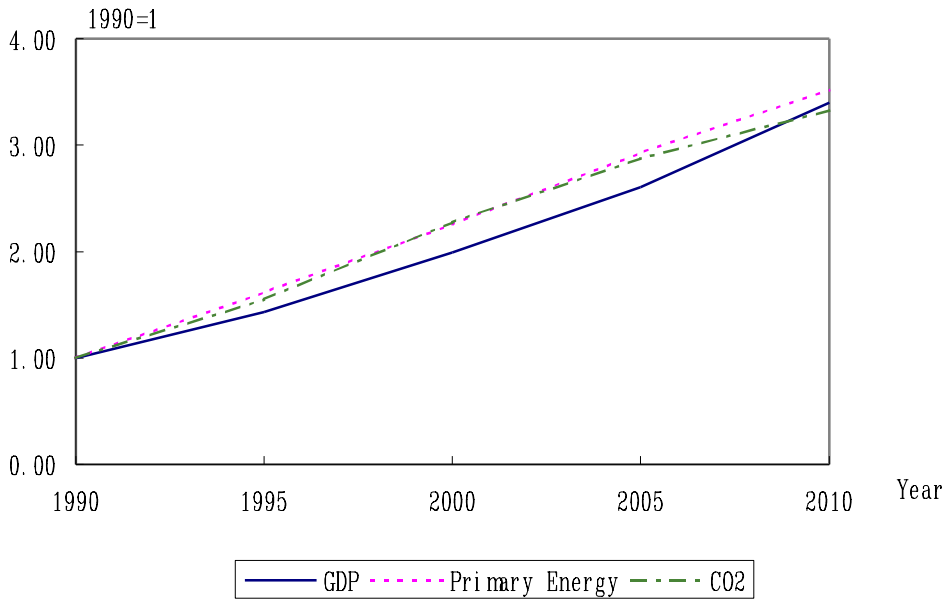


Chapter 4
[Figure 4-1] Energy Demand Projection



[Figure 4-2] CO2Emissions Projections

[Figure 4-3] Comparison of GDP, Primary Energy Demand, and CO2Emissions



4. Uncertainty

Projection of energy demand and CO2 emissions involves intrinsic uncertainty. No model can predict these with absolute accuracy. Assumptions onsocio-economic variables required for projection also have a sizable margin of error. Thus projection results can change significantly depending on models and assumptions.

One of the most important variables used for energy demand projection is GDP, especially for countries with high dependency on foreign trade, as well as a heavy industry-oriented economic structure. Projected GDP growth rates are borrowed from a report of Korea Development Institute (KDI hereafter). Since the projected numbers on key macro indicators from the KDI's report were the only available data, they were utilized as the future macro indicators. Unfortunately, however, the Korean economy is now facing financial turmoil that had not been expected, so the projected economic growth rates used in this report will have to be adjusted in the next National Communication along with corresponding energy demand and CO_2 emissions.

Reading this report, one should bear in mind that the actual economic growth rates at least between 1998 and 2000 must be below the projected and assumed economic growth rates, but to an uncertain degree.

Demand for electricity increases as income grows. Liberalization and introduction of competition by deregulation in the electricity industry would lower prices and reduce investment for demand side management and conservation. However, the range of demand increase is difficult to measure at the present.

Korea is located in the middle latitudes of thenorthern hemisphere. This location causes a significant difference between temperature and humidity in summer and winter. In summer, electricity is required for space cooling, and natural gas and petroleum products are used for space heating in winter. The seasonal variation in energy consumption due to climate change is likely to influence energy demand significantly, but it could not be properly incorporated in the demand projection, for there is no precise forecast on climate change.

Projections of energy demand and CO2 emissions fully reflect official government energy plans for Korea, including supply of and demand for petroleum, natural gas, and electricity.

Plans include equipment and facility investment on the supply side. A change in economic and social conditions, however, may change government investment plans that will, in turn, work as a constraint in the supply side. Thus, there is also uncertainty in government plans.

Fluctuation of future energy prices enlarge the margin of error of energy demand projections because energy prices directly affect energy consumption. As energy prices are not easily predictable even with a reasonable degree of accuracy, especially for the long term, when there's a significant change in energy prices, one should expect a sizable shift in energy demand.

The unmeasurable change in consumption patterns, the unpredictable speed of development in energy technology, and changes in economic and social conditions increase uncertainty in energy demand projections.

5 Greenhouse Gas Emissions Mitigation Policies

1. Energy Sector

1.1. Energy Conservation and Efficiency Improvement

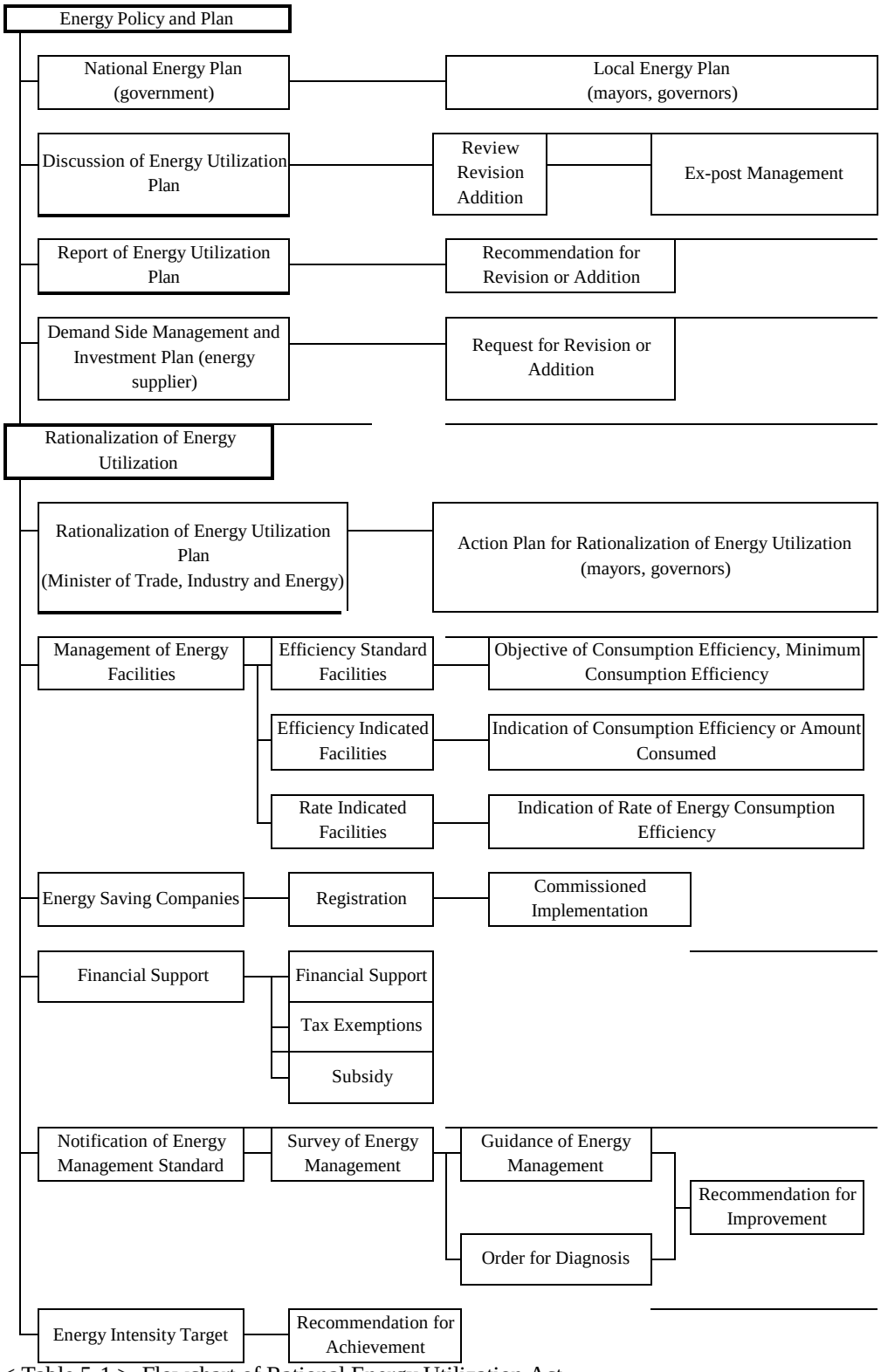
1.1.1. Legal Background

The Korean Government has been pursuing energy efficiency and conservation policies since the two oil crisis in the 1970s. The efforts were reinforced to a great extent following the Rio Conference on Environment and Development in 1992.

The Government enacted the Heat Management Act in 1974 to systematically implement energy conservation policies. Also, in 1979, it promulgated the Rational Energy Utilization Act, which calls for more comprehensive and aggressive policies than did the Heat Management Act.

Recognizing the urgency of energy conservation need, the National Committee for Energy Conservation was established in 1997 to drive forward more effective implementation of energy conservation policies. In addition, the Rational Energy Utilization Act was revised in the same year to incorporate a 'pre-notification system of energy prices', which is expected to make consumers more responsive to energy prices than otherwise. Starting from 1998, the Government plans to ban the production and sale of appliances and equipment which do not meet the Minimum Efficiency Performance Standards.

The foregoing constitutes the legal framework under which the Government is striving to transform Korea into a low energy consuming society by establishing and enforcing various energy conservation and efficiency improvement policies in industry, building, transportation, and residential sectors.



< Table 5-1 > Flowchart of Rational Energy Utilization Act

1.1.2. Government Energy Institutions and Policy Processes

The Korean Government has long intervened actively in the energy sector. Prior to 1978, the Ministry of Trade and Industry (MTI) was responsible for energy related matters. In 1978, the Energy Division of MTI was separated to form the Ministry of Energy and Resources (MOER). This Ministry had responsibility for planning and guiding all energy-related activities, with the exception of the nuclear power safety program, which remained under the responsibility of the Ministry of Science and Technology. In 1993, MOER was again merged with MTI to form the Ministry of Trade, Industry and Energy (MOTIE). In cooperation with the Ministry of Finance and Economy, MOTIE maintains a strong degree of ***control*** over all aspects of energy policy formulation and implementation. In addition, the Government has directly funded major energy corporations and research institutes.

1) **Korea Energy Economics Institute** (KEEI)

KEEI conducts basic research on conservation and energy efficiency policy for the Government. Data collected and analysis conducted by KEEI help the Government formulate its short- and long-term energy conservation policy.

KEEI provides comprehensive national energy data, including the "Yearbook of Energy Statistics," to the central and local Governments.

2) Korea Energy Management Corporation (KEMCO)

KEMCO is the Government agency in charge of implementing the energy efficiency and conservation policies and programs developed by the Government. Established in 1980, KEMCO has a wide range of programs related to the major end-use sectors. These programs fall in the following areas:

energy audits and technical guidance

research, development and demonstration

education, training and information services

management of energy-using equipment and appliances

financial and technical support for R&D and efficiency investments

coordination and promotion of R&D for new and renewable energy

total energy supply, i.e., cogeneration and district heating projects

KEMCO has a staff of 780 in its main office in Seoul, 12 branches, and three separate centers: the Urban Mass Energy Supply Center, R&D MCER (R&D Management Center for Energy and Resources), and the Industrial CHP Center. Technical personnel account for 60% of the total staff. KEMCO's combined annual budget is about US$ 25 million, of which about 70 percent comes from the Government and the balance comes from revenues for services rendered.

3) Korea Electric Power Corporation (KEPCO)

The electricity sector in Korea is monopolized by the Government-owned Korea Electric Power Corporation (KEPCO). KEPCO is responsible for all aspects of electricity supply in Korea. It operates 85 percent of installed capacity and all transmission and distribution facilities. There has been an increasing number of private power producers who are authorized to run power plant for their own use but are required to sell excess supply of electricity only to KEPCO

4) Korea Gas Corporation (KOGAS)

The Government, through its ownership of the Korea Gas Corporation (KOGAS), plays a significant role in the gas sector. KOGAS owns and operates all the LNG receiving terminals and the natural gas trunk and branch pipeline network. However, the distribution and sale of natural gas in Korea is conducted by private companies which have the exclusive right to operate within a defined area.

5) Korea Institute for Energy Research (KIER)

Established in 1981, KIER is the main energy technology research institute in Korea. It is funded by the Government and industries. It has 350 employees, of which 270 are researchers.

KIER is divided into two principal divisions: the Energy Conservation Research Center and the Alternative Energy Research Center. The latter is further divided into Combustion Equipment, Building Energy and Industrial Energy Research Departments. The Energy Technology Policy Division conducts analyses for the purpose of setting priorities in research and development activities. KIER also develops building and appliance standards on behalf of MOTIE and KEMCO.

6) Korea District Heating Corporation (KDHC)

KDHC was established by the Government in 1985 to supply district heating systems to Korea. It was restructured as a public corporation in 1992 based on the Integrated Energy Supply Act. KDHC is the largest 'district heating utility company' in Korea.

The private sector and local Governments may participate in district heating projects. The Government, through KDHC, supports district heating schemes through the provision of loans with favorable terms from the Special Energy Account.

KDHC begun supplying district heating to southern Seoul in 1987. There are currently seven district heating systems, all built within the past 10 years, and six of these are owned and operated by KDHC. At present, about 4 percent of the heating market is supplied by district heating. The Government plans to increase this figure to 15 percent nationwide by 2001.

1.1.3. Industrial Sector

1) Establishment of Energy-Intensity Targets by Product

The Government has established energy intensity targets by product and has been encouraging energy-intensive industries to achieve these targets. Based on the 1992 Five-Year Energy Conservation Plan, the Government specified annual energy-intensity targets for 161 energy-intensive products from 1992 to 1996.

Meanwhile, the Korea Energy Management Corporation collects and analyzes energy consumption data of energy-intensive products. It distributes the results to other companies producing similar products to help guide their voluntary efforts in improving energy efficiency.

Classification	1984~ 90	1991	1992	1993	1994	1995	1996
Number of Companies	424	30	178	176	176	176	176
Number of Products	759	5	161	158	158	155	155
Savings(1,000TOE)	700	-	705	668	998	900	810
Rate of Improved Intensity(%)	6.6~ 8.8	-	2.2	1.9	2.7	2.4	2.0

< Table 5-2 > Outcome of Industrial Energy-Intensity Improvement Efforts

2) Five-Year Energy Conservation Plan for Energy-Intensive Industry

The First Five-Year Energy Conservation Plan for Energy-Intensive Industry was launched in 1992, targeting energy-intensive companies using more than 20,000 TOE per year. During the planned period, 2,344 billion Won was invested in energy conservation and efficiency improvement projects. It is estimated that the conservation effects from this plan amount to a 14% reduction, compared to 1991.

Classification	1992	1993	1994	1995	1996	Total
Savings (%)	2.6	2.4	3.6	3.3	2.9	14.8
Investment (100 mil. Won)	7,538	5,519	3,606	3,395	3,382	23,440

< Table 5-3 > Implementation of First Five-Year Energy Conservation Plan for Energy-Intensive Industries

With the completion of the first plan in 1996, the Second Five-Year Energy Conservation Plan (1997-2001) is underway, targeting at 190 companies using more than 30,000 TOE per

year. These companies account for 54 percent of the energy use in the industrial sector. The goal of the second plan is to save 10 percent of total energy consumption.

Sector		Chemicals	Metals	Ceramics	Paper	Textile	Food	Total
Number of Companies		55	48	24	25	24	14	190
	Ratio(%)	29	25	12	14	12	8	100
Energy Savings (1,000 TOE)		10,366	15,035	5,288	1,100	1,713	460	33,962
	Ratio(%)	31	44	16	3	5	1	100

< Table 5-4 > The Second Five-Year Energy Conservation Plan for Energy-Intensive Industries .

To achieve this goal, the Government will set annual energy conservation targets and invest a total of 3,097.8 billion Won in the plan.

Year	1997	1998	1999	2000	2001	Total
Savings(%)	2.3	2.0	2.4	1.9	1.3	9.9
Savings(1,000TOE)	791	652	871	619	434	3,367
Investment (100 mil. Won)	3,374	2,699	15,305	5,928	3,672	30,978

< Table 5-5 > Investment Plans and their Corresponding Energy Conservation Potential

As seen in Table 5-6, the energy conservation target for the chemicals and chemical products industry is set at 11% with an investment of 715.6 billion Won, while that for the metals industry is set at 6.8% with an investment of 1,588.6 billion Won.

Year	Chemicals	Metals	Ceramics	Paper	Textile	Food
Savings(%)	11.0	6.8	12.7	17.8	15.7	15.5
Savings(1,000 TOE)	1,138	1,023	670	196	268	72
Investment (100 mil. Won)	7,156	15,886	3,024	2,994	772	790

< Table 5-6 > Energy Conservation Plan by Industry

The principal means to achieve these targets include replacement or retrofitting of equipments, improvement of operation and process efficiency, waste heat recovery, and heat insulation.

Classification	Replacement, Retrofitting	Improvement of Operations and Processes	Waste Heat Recovery, Heat Insulation	Operation Management	Fuel Substitution, Others	Total
Savings (1,000 TOE)	1,329 (39.5)	514 (15.2)	507 (15.1)	414 (12.3)	603 (17.9)	3,367 (100)
Investment (100 mil. Won)	21,328 (68.8)	2,711 (8.8)	1,147 (3.7)	2,864 (9.2)	2,928 (9.5)	30,978 (100)

< Table 5-7 > Energy Conservation Plan by Measure

Note: ( ) denotes the percentage.

The Government will continue to improve energy intensity for 106 major products by establishing and enforcing energy conservation targets for these products.

Industry	Products	Energy Intensity(Mcal/T)		
		1997	2001	Improvement(%)
Chemicals	Ethylene	4,862	4,636	4.6
Metals	Crude Steel	5,316	5,118	3.7
Ceramics	Cement	261	256	2.0
Paper	Vellum Paper	3,151	3,046	3.3
Textiles	Polyester	1,734	1,527	11.9
Food	Sugar	856	820	4.2

< Table 5-8 > Improvement of Energy Intensity by Product

Note: Energy intensity is weighted average of similar products.

3) Preparation of Energy Management Guidelines

In accordance with Article 24 of the Rational Energy Utilization Act, the Government prepares the Energy Management Guidelines and distributes them to as many companies as possible to help them use energy more efficiently. Audits and consultations mainly focus on small and medium companies that have relatively poor energy management. Under this

program, 30 companies (two each from 15 different industrial subsectors) were selected and required to take energy audit each year between 1987 and 1991. In 1992, the program was expanded to cover all industrial subsectors. In 1996, 350 companies were audited and provided technical guidance and consultation.

Classification	1991	1992	1993	1994	1995	1996
Covered Industry	Chemicals·Food	All Industries	All Industries	All Industries	All Industries	All Industries
Number of Companies	30	250	187	455	350	350
Compliance Rate(%)	62.8	60.5	57.0	80.0	80.0	70.0

< Table 5-9 > Registration of Energy Management Standards Enforcement

In accordance with Article 11 of the Rational Energy Utilization Act, the Government requires that companies prepare and submit energy utilization plans before the start of operations when they construct new factories or expand factories which consume more than 1,000 TOE per year or 40,000 MWh per year. This requirement aims to encourage these major users to install energy-efficient facilities.

Classification	1991	1992	1993	1994	1995	1996
Number of Submissions	24	17	21	23	37	30
Energy Consumption (1,000 TOE/year)	2,300	7,520	1,273	1,135	5,794	5,075
Savings (1,000 TOE/year)	159	76	174	204	797	428

< Table 5-10 > Energy Utilization Plans

4) Energy Audit Program for Industry

Energy audits have been conducted by KEMCO since 1980, which maintains six specialized audit teams for the chemical, metal, ceramic, textile, pulp and paper, and food industries. Audits are provided free of charge to small and medium companies, while some fee is charged for large company audits. Audit teams recommend necessary efficiency improvement measures based on cost and benefit analysis of equipments and management.

KEMCO audited 61 large companies and 350 small and medium companies in 1996. Execution of the program resulted in the energy savings equivalent to 125,000 TOE. The Government plans to continue its energy audit program.

	1980-1991	1992-1994	1995	1996	Total
Number of Companies	1,245	1,048	405	411	3,109

< Table 5-11 > Energy Audit Program

5) Improvement of Industrial Equipment Efficiency

The Government is making an effort to improve the efficiency of equipment used in industry by encouraging the replacement and retrofit of old and inefficient boilers, kilns, furnaces, and motors by high efficiency ones. These efforts include tax incentives and financial assistance.

Each year, 30 billion Won has been paid for the replacement or retrofit of old and inefficient equipments. In addition, 5 percent of total replacement/retrofit investment is tax deductable from corporate tax or income tax.

The Government selected development of high-efficiency motors as one of its high priority research projects in 1993. The Government plans to replace all motors with the high-efficiency ones by 2006 through extensive efforts in development and commercialization.

In addition to including motors in its efficiency standards list, the Government has ordered energy suppliers such as KEPCO to include high-efficiency motors in demand-side investment plans.

6) Co-generation Plants

A total of fourteen co-generation plants are already in commercial operation at twelve industrial complexes in such areas as Ulsan, Yuchon, and Gumi to provide heat and electricity. Construction of additional five cogeneration plants is expected at the Daesan and Jinju industrial complexes.

Number of Cogeneration Plants	Number of Consumers	Generation	
		Heat(Gcal/h)	Electricity(MW)
14	474	4,320	1,047

< Table 5-12 > Cogeneration Plants in Industrial Complexes (1996)

Concerning the development of new industrial complexes, the Government has called for mandatory consultations to determine the feasibility of constructing co-generation plants and providing favorable financing, so as to boost the number of co-generation plants to 33 by the year 2001.

7) Funding for Energy Conservation Facilities

Under the Rational Energy Utilization Act, the Government provides funds to industrial, building, transport, and residential sectors in order to promote energy conservation.

A special fund has been reserved for energy conservation facilities since 1980. Total funds raised reached 2,780.9 billion Won in 1996. The fund is divided into three categories: facilities, R&D, and operations. Interest rates on the fund range between 5 and 10%. More fund will be made available, to 258.3 billion Won in 1997 and to 305.0 billion Won in 1998.

1980-1991	1992	1993	1994	1995	1996	Total
19,746	1,146	1,376	1,863	1,699	1,979	27,809

< Table 5-13 > Funding for Energy Conservation Facilities (Unit : 100 mil. won)

1.1.4. Residential·Commercial Sectors

1) Insulation

The use of insulation in new building construction has become mandatory since 1979. Since 1984, the Government has provided financial support for insulation retrofits in old buildings. Between 1984 and 1996, insulation retrofits in 24,265 residential dwellings were financed by the Government, costing 71.1 billion Won. In 1997, this fund will provide 2 billion Won.

Classification	1984-1990	1991	1992	1993	1994	1995	1996	Total
Financial Assistance (100 mil. Won)	534	50	30	24	27	20	26	711
Number of Households	19,685	1,606	903	615	628	414	414	24,265

< Table 5-14 > Financial Support for Housing Insulation

2) Building Audits

Since 1990, large buildings which use more than 4 million kWh per year have been designated for intensive audits and supervision. Buildings which reduce their electricity use by 10 percent from the previous year would retain 20 percent of the savings through reduced electricity charges.

Between 1980 and 1996, KEMCO conducted 299 in-depth audits of large buildings and 1,674 audits of public buildings.

Classification	1980-1990	1991	1992	1993	1994	1995	1996	1997 (planned)	Total
In-depth Audits	225	12	10	14	16	9	13	10	309
Audits of Public Buildings	984	120	120	120	120	120	90	70	1,744
Total	1,209	132	130	134	136	129	103	80	2,053

< Table 5-15 > Annual Energy Audits(unit : number)

3) Energy-Efficient Design for New Buildings

Beginning in 1985, the Government requested that building permit applications for large buildings be accompanied by an energy efficiency plan for each building. This request was intended to encourage builders to go beyond the prescribed minimum energy efficiency standards. Since 1992, new buildings with an area greater than 10,000 ? must energy efficiency plans.

The energy efficiency standards for building design has changed to a unified efficiency standard based on energy saving performance from the previous separate standards for walls, ceilings, and windows, etc. Energy efficiency standards were established in 1995 for hotels, hospitals, public baths and indoor swimming pools.

4) Management of Energy Intensive Buildings

Since 1992, large buildings which use more than 4 million kWh per year have been designated for intensive audits and supervision. As of 1996, 236 buildings (i.e., hotels, banks, offices, department stores, hospitals, and others) were being supervised and audited under this program.

In 1997, 85 buildings using more than 10 million kWh/year were required to submit Five-Year Plans for Energy Savings. the Energy consumption of these buildings accounted for around 53% of the total consumed by the 236 energy-intensive buildings. Buildings that reduce electricity consumption by 10% compared to the previous year are rewarded by reduced electricity fees.

5) Equipment and Appliance Standards and Labelling

The Government has implemented a number of labelling and standard measures to improve energy efficiency of equipment and appliances as well as passenger vehicles. Beginning in 1992, labelling which specifies energy use and intensity must be affixed to six types of products including refrigerators, air conditioners and passenger cars. This rating/labelling system is intended for raising public awareness on energy efficiency.

From 1994, minimum efficiency standards have been applied to energy-intensive products such as refrigerators, air conditioners, incandescent and fluorescent lamps, and electric ballasts. In 1997, the Government publicly announced products in five energy-intensive product categories which fell below the minimum efficiency standards and recommended their producers (or importers) to meet the standards.

From 1998, in an effort to strengthen the enforcement of the minimum efficiency standard, the Government will authorize the Minister of MOTIE to ban production and sales of the

appliances and equipments that fall below the minimum energy efficiency standards with no apparent reason.

6) Energy Service Companies (ESCOs)

Enhancing the role of energy service companies (ESCOs) in the energy conservation market has been identified as a high priority. As of 1997, 12 ESCOs had been registered. In order to further boost ESCO activities and to encourage third-party financing, the Government has provided soft loans and tax incentives for investments in energy efficiency projects.

In 1996, the Energy Saving Mart was inaugurated to provide a match-making venue for ESCOs, major energy consumers and their most promising potential customers. Encouraged by the success of this program, the Government now is planning to hold the event on an annual basis.

	1994	1995	1996	1997	Total
Financial Assistance	43	28	57	230	358

< Table 5-16 > Financial Assistance to Energy Service Companies
(unit : 100 mil. Won)

Another major program undertaken in 1996 was Energy Savings Performance Contracting. Under this program, energy efficiency investments are made by ESCOs, and the resulting savings are divided among the participants.

7) District Heating (DH)

District heating is considered an efficient mean of energy conservation and pollution reduction. The role of district heating has expanded as a result of the Government's district heating mandate. In 1992, Korea's integrated Energy Supply Act called for nationwide expansion of the district heating system.

As of 1996, 620,000 households in Seoul metropolitan area, equivalent to 6 percent of the residential market, were supplied with district heating. By the year 2001, district heating will

be supplied to 1.8 million households, which will by then account for 15 percent of the residential market.

In 1996, the fuel used in DH for 627,000 households was around 513,000 TOE. Using conventional central heating instead of DH, the energy use would have been 969,000 TOE. In 1997, the amount of fuel saved due to DH is expected to be 1.9% of the combined total of residential and commercial energy consumptions, or 655,000 TOE.

1.1.5. Transportation Sector

1) Fuel Economy Rating/Labelling Program for Automobiles

The Fuel Economy Rating Labelling Program has been applied to 267 models of general vehicles and jeeps fueled by gasoline, LPG and diesel to provide consumers with better information on relative fuel efficiency. This program will soon be extended to buses.

2) Establishment of Fuel Economy Targets

The Government has established fuel economy targets to encourage manufacturers to make energy-efficient vehicles. The goal is to improve fuel economy for all classes of vehicles by 5 percent in 1996 and 10 percent by 2000 over the 1991 base year.

Class(cc)	1996	2000
less than 800	23.4	24.6
800-1,100	20.3	21.3
1,101-1,400	17.3	18.1
1,401-1,700	15.4	16.1
1,701-2,000	11.4	12.0
2,001-2,500	9.9	10.4
2,501-3,000	8.5	8.9

< Table 5-17 > Fuel Economy Targets in Passenger Cars (unit: Km/ l)

3) Passenger Vehicles' Operation day Management System

The dramatic increase in the number of cars since the mid-1980s has resulted in heavy traffic and an energy-intensive society. To cope with these problems, public employees have participated in the voluntary 'Passenger Vehicles' Operation day Management System' to encourage those with private vehicles not to drive their cars every 10th day and ride to work with a colleague. Under the program, when the last digit of a vehicle's licence plate is the same as the last digit of the date, then the owner should not drive his car on that day. This Program has also been promoted in large companies and is encouraged through a variety of public information campaigns.

The Government also encourages car owners to ride with a colleague (car pool) and to use public transportation. It is considering offering such incentives as toll-charge discounts for car pool participants.

4) Education for Economical Driving

The Government is promising on education program on economical driving the new licensees and commercial vehicle drivers.

Pamphlets and videotapes have been supplied to driver testing centers and private driving schools as educational materials. In 1995, more than 100,000 drivers were shown the videotapes. In 1996, the total number of drivers in the program reached to about 300,000.

5) Promoting Small Car Ownership

To decrease energy consumption in the transportation sector, the Government encourages the purchase of smaller and more fuel-efficient cars.

The Government is providing various incentives including tax reductions for smaller car, such as a 2% registration fee instead of the 5% for large and medium-sized vehicles and a 50% deduction in the license fee. Tax incentives for light weight vehicles include reductions in automobile tax, registration tax, license tax, integrated insurance premium, discounts on highway tolls and parking charges, and exemption from the special surcharges on a second family car.

6) Progressive Emissions Tax by the Automobile Engine Size

The Government has imposed progressive emissions taxes to reduce the demand for motor vehicles and control the demand for large cars.

The emissions tax on private cars with engine size above 3,000 cc is 370 Won/cc, while that on private cars with engine size less than 800cc is 100 Won/cc. Households with more than one car pay double the tax on the additional car.

Class	Passenger Car	Jeep
over 3,000cc	370	230
3,000cc ~ 2,500cc	310	200
2,499cc ~ 2,000cc	250	180
1,999cc ~ 1,500cc	220	160
1,499cc ~ 1,000cc	160	160
999cc ~ 800cc	120	120
under 800cc	100	120

< Table 5-18 > Automobile Tax by Engine Size (unit : Won/cc)

7) Construction of National Oil Pipeline

The construction of a nationwide oil pipeline-network is expected to mitigate traffic by reducing the numbers of oil tankers on expressways by 7,000 per day, saving transportation costs as well as reducing air pollution.

Pipelines between the southern and northern areas of the country and the construction of a storage facility in Taejon were completed in June 1995 and were put in operation in the area south of Taejon. Since the Sungnam storage facility were finished in June 1997, the national pipeline grid is now operating in its entirety along a south-north line traversing Korea.

1.1.6 Public Sector

1) Promotion of Energy Savings Performance Contracting

Energy Saving Performance Contracting (ESPC) has been introduced to the public sector under this program. The rewards of energy conservation are distributed among the public

sector and $ESCO_S$.

As of June 1997, this type of contract was being tested in the pilot phase. Based on the results of the pilot project, contracts will be revised and expanded to all public-sector buildings to stimulate implementation of this program as a mean of energy conservation.

2) Encouraging the Public Sector to Use Energy-Efficient Appliances

Beginning in 1997, the Government made it a priority for the central Government agencies and local administrations to use energy-efficient equipment and appliances, such as high-efficiency motors and 26mm slim-type fluorescent lamps. The Government will closely monitor the effects of such energy-saving activities and provide related information through workshops and other public campaigns.

3) Inclusion of Energy Conservation Category in the Management Assessment of Government-Invested Organizations

From 1986, the Government began to consider the energy conservation achievements index as an important factor when evaluating the overall performance of Government-invested organizations with a view to enhancing energy conservation awareness followed by energy conservation oriented management practices.

In 1997, the energy conservation index was given more weight in the assessment. and applied to all Government-invested organizations.

1.2. R&D in Energy Technology Development

1.2.1 Ten Year National Plan for Energy Technology Development

The Government has set out a Ten-year National Plan for Energy Technology Development (1997-2006) which incorporates the following three areas: energy conservation technology, alternative energy technology, and clean energy technology.

The main goals of the plan are to reduce total national energy consumption by 10% in 2006, and to supply 2% of the total national energy consumption by new and renewable energy in 2006 through the investment of 2,047 billion Won.

This plan targeted twenty one major technologies of which characteristics are firstly the high energy conservation potential, secondly environmental friendliness, and lastly the high capital investment cost which keep private companies from making R&D investments.

Classification	Key Development Programs
Energy Conservation Technology (12)	Industrial furnace, Mass energy, Unused energy, Separation technology, Dryer, Small cogeneration, Energy conversion storage, Energy conservation building technology, Air-conditioning and ventilation system, Lighting system, Induction motor, Application of motors
Alternative Energy Technology (4)	Solar, Thermal, Photovoltaic, Fuel Cell, IGCC
Clean Energy Technology (5)	Fluidized-bed combustion, coal-ash utilization, New catalyst technology, Post-combustion processing technology, Co2 separation and recovery technology

< Table 5-19 > Ten-Year Technology Energy Development Plan

1.2.2. New and Renewable Energy

Since the Second Oil Crisis in 1978, the Government has put great effort into developing and encouraging the use of indigenous new and renewable energy to reduce korea's import-dependence on fossil fuels such as petroleum.

In 1987, the Government enacted the New and Renewable Energy Development & Promotion Act. The Alternative Energy Technology Development Plan was established based on this Act to develop and disseminate twelve major alternative energy technologies such as solar thermal, and photovoltaic power, bio energy, small hydro power, fuel cells, wind power, coal gasification, waste and geothermal energy, and hydrogen technology.

Five percent of the total investment in these projects is tax deductible in order to promote and expand the use of new and renewable energy. Loans are provided at 5% interest on up to 80% of the total investment. Golf courses and outdoor shooting ranges are required to install solar hot water systems. Pilot projects on photovoltaic power plants on remote islands and in isolated areas are underway to create demand for new and renewable energy and to improve their reliability.

The Government has invested 99 billion Won in new and renewable energy R&D technologies, working with the private sector. From 1988-1996, investment was made for 242 projects in 11 research areas including photovoltaic power, fuel cells, bio energy and waste energy. As a result, the annual growth rate of new and renewable energy has been around 23% over the last five years.

Classification	1991	1993	1995	1996	Annual Growth Rate (92-96)
Total Energy Demand	103,622	126,879	150,437	165,209	9.6%
New and Renewable Energy	413	649	909	1,162	23.0%
Share(%)	0.40	0.51	0.60	0.07	-

< Table 5-20 > New and Renewable Energy Consumption by Year (unit: 1,000 TOE)

The total amount of new and renewable energy from waste energy, bio energy, small hydro power, and photovoltaic power was 1,162,000 TOE in 1996. Waste energy accounted for more than 90% of those.

Classification	Solar Energy	Bio Energy	Waste Energy	Small Hydro Power etc.	Total
Amount(1,000 TOE	35	51	1,056	20	1,162
Share(%)	3.0	4.4	90.9	1.7	100

< Table 5-21 > Use of New and Renewable Sources of Energy by Sector(1996)

Prior to 1988, new and renewable energy usage consisted only of small hydro power plants and facilities using methane gas. However, since 1989, incineration facilities and residential solar hot water systems have come to the forefront in the new and renewable energy consumption. Since 1988, the Government has invested 79.2 billion Won in photovoltaic power facilities, 33.9 billion Won in waste power facilities, and 5.7 billion Won in small hydro power facilities.

Classification		1988-1993	1994	1995	1996	Total
Facility Fund	Waste	301.4	2.9	9.5	2.9	338.8
	Solar Energy	318.9	137.2	114.8	221.4	792.4
	Small Hydro Power	28.5	13.9	10.36	4.5	57.3
	Methane Gas	32.0	2.8	7.1	2.2	44.3
	Alternative Fuel	26.5	5.2	5.5	6.2	43.6
	Wind Power	2.4	-	-	-	2.4
	subtotal	709.8	184.1	147.4	237.4	1,278.9
Operation Fund		22.7	3.5	2.5	4.9	33.7
Total		732.6	187.6	149.9	242.3	1,312.6

< Table 5-22 > Financial Support for Expansion of New and Renewable sources of Energy Consumption by Year and Category(1988-1995)

According to the Ten-year National plan for Energy Technology Development, the Government is aiming at the supply of 2% of total energy demand by new and renewable energy. To realize this plan, the major focus of R&D development has been placed on advanced and applicable technologies such as solar thermal, and photovoltaic power, fuel cells, and the combined power of coal gasification technology, in joint research by industry, academia and research institutes.

	1st stage	2nd stage	3rd stage	4th stage
Period	1988-1991	1992-1996	1997-2001	2002-2006
Development goals	Establishing research basis	Establishing basis for utilization	Developing high-priority technology	Commercializing technology
Dissemination goals (the ratio of alternative energy to total energy)	Securing basic technology (0.5%)	Creating demand, initiating demonstrational dissemination (0.6%)	Creating market (1.3%)	Expanding dissemination (2.0%)

< Table 5-23 > Plans for New and Renewable Sources of Energy Technology Development

1.2.3. Current Situation and Planning for New and Renewable Energy

1) Photovoltaic Power

Three photovoltaic power plants are in operation. A photovoltaic power plant of 100 KW on Ho island in Chungnam was built with domestic materials and equipment in 1993, and another facility on Hawha island in Chunnam was upgraded from 25 KW to 60 KW. To publicize photovoltaic power plants, a new exhibition center was opened in 1997 at Jungyeo Park in Kwangju city.

The electricity generation costs of photovoltaic plants are similar to those of diesel power plants. Photovoltaic power plants, however, do not have the same noise and transportation problems as diesel power plants and require relatively low maintenance costs. The Government concluded that photovoltaic power plants are the most appropriate power systems for small islands with less than 50 households so that beginning 1998, the Government plans to build such plants on 100 small, remote islands.

2) Solar Thermal Energy

Different from other heating systems, solar thermal types require relatively low initial investment cost and have proven to be economical. The Government is making efforts to spread residential use of solar hot water systems in rural areas and small and medium-sized cities.

3) Bio Energy

Bio energy technology consists of ethanol fuel production and methane gas from biomass. Methane gas conversion technology is being used in liquor factories and food industries. The construction of pilot plant for ethanol fuel products came to completion in May 1993, which has production capacity of 1 kl per day.

Although ethanol fuel is inferior to gasoline in economic terms, the Government is determined to continue its effort for technology development in this area and later to institutionalize a mechanism through which the user of this fuel for automobiles will be enhanced.

4) Energy from Municipal Waste

Concerning energy from waste, the Government continues to disseminate municipal solid waste incinerators linked with district heating and industrial waste incinerators. Combustible waste from municipal waste has a calorific value of more than 5,000 kcal/kg, with high conversion potential into heat energy. Installation of incinerators are of increasing popularity as technologies for utilizing heat from waste incinerators and associated air pollution prevention are developing.

Four hundred and ten industrial waste incinerators have been installed across the country. In 1993, the Waste Management Law was revised to encourage industrial complexes to use their waste as a feedstock for waste heat production. New industrial complexes with areas of greater than 500,000 ? are required to install collective industrial incinerators. In the future, the Government will promote the spread of industrial incinerators to solve waste disposal problem and at the same time to make most of the heat energy generated from waste incineration.

5) Wind Power

Energy generated from wind power would be economically feasible if the average wind speed is more than 4~ 5m/sec. In Korea, wind energy resources are available in Moslpo, Cheju island, small islands in the southwest, and near Daekwallyong pass.

A feasibility study for a pilot-phase wind power generation plant at Wolyung, Cheju Island is underway. Depending on the outcome of the study, the Government will decide whether to build the power plant using both photovoltaic and wind power in the small islands which do not have an access to the national electricity power distribution network. In addition, the Government along with Cheju provincial government, is currently constructing a wind power plant with the installed capacity of 5,200 kWh as a pilot phase local energy project. The total investment cost for the project is 12 billion Won for three years from 1996 to 1999.

	Dissemination Status
Solar Heat	o Residential Solar Hot Water System: 84,000 units (as of the end of '96)
Photovoltaic Energy	o Photovoltaic Energy for Islands and Special Purposes : 7,600 units (total 2,161kW) -Ho Island : 100kW('92), Hahwado Island 60kW('95), Marado Island 30kW('91)
Bio Energy	o Facilities using Methane Gas : 93 units
Waste Energy	o Municipal Waste : 11 units o Industrial Waste : 410 units
Small Hydro Power	o Research for potential areas : 150 MW o Small Hydro Power : 37 MW(20 units)
Wind Power	o 170kW, 80kW at Muan, Chunnam('94.11) o 100kW, 30kW and 20kW at Wulyong, Cheju ('95.4) o 250kW at Jungmoon, Cheju('92.10)

< Table 5-24 > Utilization of New and Renewable Energy by Source

1.2.4. Energy Conservation Technology

The Government has long supported the development of energy conservation technologies which could have economic value with great energy saving potential in the near term. From 1992-1996, 111 of 289 projects were completed and 23 among these are now in practical utilization.

	1992	1993	1994	1995	1996	Total
Project	11	111	60	34	73	289

<Table 5-25 > Projects for Energy Conservation Technology

Based on the 10-Year National Plan for Energy Technology Development, the

Government will systematically support the development of 12 technologies with high energy saving potential and 32 general technologies.

	1st Stage	2nd Stage	3rd Stage
Period	1992-1996	1997-2001	2002-2006
R&D Strategies	Focus on tasks which can be utilized in the near term Establish research base among industry, academia and research institutes and secure technological basis. Among the research tasks, the results of 22 tasks are being utilized.	Secure technical potential with focus on high priority programs (to account for 70% of total conservation volume) Initiate utilization and dissemination of the results of R&D, and establish institutional base. Establish the basis for international cooperation for the third stage of high- priority programs.	Develop future-oriented and large-scale technology led by the high-priority programs (mid-entry through international cooperation) Achieve conservation goal through the realization of the potential For programs other than high-priority programs, maximize the research capabilities of the private sector through various measures, thereby enhancing conservation.

< Table 5-26 > Energy Conservation Technology Development

1.2.5. Clean Energy Technology

Clean energy technologies such as clean burning coal, heavy oil upgrading through desulphurization, and anti-pollution facilities are in the development stage. Forty-five projects have been underway since 1994 and three have been completed.

Under the 10-year national plan, five technologies including state-of-the art fuel combustion, improved combustion processes and new catalysts have been selected and financed as major programs to achieve clean energy technology by 2006.

Classification	1994	1995	1996	1997	Total
Projects	19	4	12	10	45
Investment	23	25	36	74	159

< Table 5-27 > Clean Energy Technology Development (unit : number, 100 mil. Won)

1.3. Demand Side Management

1.3.1. Pricing System

The Government has played a central role in the price-setting process for most forms of energy. It imposes customs tariffs, VAT, special excise tax, traffic tax, and other surcharges on primary energy sources such as oil, LNG, and coal to limit energy consumption and increase revenues. In the case of oil, a surcharge of $1.70 and a 5% customs tariff per barrel, and 10% VAT on all types of oil is imposed at the time of import.

Until 1994, prices of petroleum products were regulated by the Government. Between February 1994 and December 1996, the Petroleum Price Fluctuation System, which closely linked domestic prices with international market prices, was used. Petroleum prices were deregulated from 1997 through the revision of the Petroleum Business Law.

Class	Tax	Crude Oil	Gasoline	Diesel	Kerosene	B-C	LPG	LNG
Import	Customs Tariff	5%						1%
	Surcharges	1.70$/B						$16.25/ton
Sale	Special Excise Tax				60 Won/l		40 Won/kg	40 Won/kg
	Auto Tax		455 Won/l	85 Won/l				
	Education Tax		68.2 Won/l	12.7Won/l	9 Won/l			
	Surcharges		90 Won/l		20 Won/l		4.5 Won/kg	4.5 Won/kg
	VAT	10%						

< Table 5-28 > Energy Taxes and Surcharges

1.3.2. Restructuring Energy Pricing Policies

In the past, it was believed that setting energy prices at low levels was needed to ensure industrial competitiveness as well as price stabilization. Thus, Korea's domestic energy prices were maintained at somewhat low levels. However, keeping energy prices low has had an undesirable effect on efforts to improve energy efficiency and reduce the environmental impact of energy consumption.

Under these circumstances, the Government recently revised its energy-pricing policies with a view to ensuring that domestic energy prices fully reflect not only the production and distribution costs, but also the social costs including environmental cost.

With the new energy-pricing policies, the level of energy prices will be adjusted gradually to the average energy prices of non-oil producing advanced countries by the year 2000 in order to facilitate energy conservation and improvement of energy efficiency and to mitigate the environmental impact of energy consumption.

To legally facilitate these policies, the Government revised the Rationalization of Energy Utilization Act in 1997 and in the near future will announce targeted prices by energy source annually and adjust prices by taxation, etc. The revenue generated by this system is to be used for investment in energy conservation facilities and development of alternative energy technologies.

1.3.3. Investment Plan for Demand Side Management

Under the 1995 revision of the Rationalization of Energy Utilization Act, energy suppliers are required to develop and implement DSM investment plans. Accordingly, major energy suppliers such as KEPCO, KGC and KDHC have developed long term plans for DSM since 1996 to improve efficiency and control load management programs. KEPCO, for example, has invested some 45 million US dollars in such DSM programs as Load Management, Time-of-Use Rate System, Discount System for Voluntary Curtailment, and Rebates for Efficient Lighting Appliances.

The Government's target is to increase DSM investment annually by 1% of total sales and It also requires energy suppliers to incorporate DSM programs in their investment plans.

	KEPCO	KGC	KDHC
Efficiency Improvement	- Dissemination of High Efficiency Lighting Appliances - Advertisements for Saving Electricity - Development of Research Projects	- Advertisements for Energy Savings - Investment in DSM Projects - Development of Energy Saving Equipment	- Research on the Optimum System of End-user Equipment
Load Management	- Installation of Electronic Meters - Voluntary Savings and Summer Vacation Price Adjustment - Dissemination of Ice Storage Systems - Dissemination of Economic Vending Machines - Midnight Power Service	- DSM Research - R&D for Gas Cooling System and Combined Equipment - Subsidy on Energy Saving Design for Gas Cooling - Research on CNG Vehicles	- Research on Heat Use Pattern and Forecast of Heat Loads -Introduction of DH in old apartments
1996	403	16	1
1997	541	43	3

< Table 5-29 > DSM Projects by Energy Suppliers

1.3.4. IRP

The purpose of IRP is to promote efficient energy use and to minimize social costs by considering demand and supply together. The Government plans to establish detailed categories and measures for IRP and to develop an action plan.

The Government continues to support basic IRP research and exchange information among Government, energy suppliers, and consumers. The Government encourages all parties concerned to draw up agreements for reasonable targets.

1.4. Local Energy Plan

The central Government helps local Governmental bodies establish their own unique and independent local energy plans. The local energy plans aim to develop an environment-friendly energy program and improve the economy and welfare of local residents by taking full account local economic, natural, and social circumstances.

Under the Rationalization of Energy Utilization Act, local Governments are now required to develop local energy plans. In 1995, feasibility studies on local energy plans were carried out for 10 local autonomous bodies. Local Government officials were invited to take training courses on local energy planing

In the future, the central Government plans to provide loans and subsidies, along with technical assistance from KEMCO, To support the local Governments' energy planning projects.

	1996	1997
Local Energy Plan	10	-
Local Energy Infrastructure	-	24
Pilot Project for Local Energy	-	50

< Table 5-30 > Initial Support for Local Energy Development Projects (unit: 100 mil. Won)

1.5. Financial Support for Energy Industry

Until 1995, the Government had provided financial support for implementing energy policies from five funds including the Petroleum Business Fund and the Energy Rationalization Fund. In 1995, these funds were unified into one special account, called the Special Energy Account, by the Special Energy Account Act legislated in 1994 in order to improve the transparency and efficiency of financial support in the energy sector.

Revenue for the Special Energy Account comes from import surcharges on petroleum and LNG, sales surcharges on diesel and safety management surcharges on LNG and LPG. Special Energy Account expenditures are allocated for the following areas: petroleum storage facilities, long-range pipeline, LNG pipeline, energy conservation, development of technologies, the dissemination of collective energy, restructuring of the coal industry, and fostering the alternative energy industry.

The budget of the Special Energy Account has been increased by more than 10% annually in reflection of the serious concern of the Government for energy and environment issues. As seen in Table 5-31, funding for petroleum and gas decreased by 12.6% (from 661.4 billion Won in 1995 to 578.2 billion Won in 1997). While funding for restructuring of the coal industry increased by 14.6%.

	1995	1996	1997
Petroleum and Gas Business	6,614	7,359	5,782
Energy Rationalization Business	2,474	2,869	3,626
Coal Industry	5,580	5,863	6,393
Mineral Development	410	590	533
Others	410	387	1,190
Total	15,078	16,477	18,729

< Table 5-31 > Budget of Special Energy Account (unit : 100 mil. Won)

Loans from the Special Energy Account are provided at low interest rates, depending on the type of business. Loans for expansion of LNG supply facilities, LPG import terminals,

and construction of pipelines for city gas are provided at 7% interest. Loans related to safety and distribution structure are provided at 6% interest. Loans are provided at 5% interest to high-risk projects such as petroleum development, development of energy technologies, and projects related to energy conservation and environment improvement.

In addition to financial support, the Government provides a variety of tax incentives to projects for the efficient implementation of energy policies. To accelerate the development of energy technology, 5% of such investment is tax deductable from income or corporate tax. A reserve fund for technology development is treated as a business expenditure. Investment for replacement of worn-out equipment and funding for energy conservation equipment is also tax deductable at 5% of the total investment.

1.6. Nuclear Power Generation

1.6.1. Historical Background

Under the Electricity Business Act, the first nuclear power plant (NPP) in Korea was built in 1978. In the 1980s, NPPs were operating commercially and provided a large share of electricity supply, more than half of the total power generated in 1987.

In the 1990's, Korea achieved technological self-reliance in this key energy sector after having induced foreign technology and succeeding in co-designing nuclear power plants. The development of Korea's standard nuclear power plant model was thus successfully achieved.

1.6.2. Current Situation and Plan for the Future

Korea now ranks among the top 10 countries in the world in the use of nuclear energy and is recognized as a country that is outstanding and successful in the development and application of NPP.

As of August 1997, 12 NPPs were operating commercially. They supplied 73.9 TWh, 36% of the total electricity supply, in 1996 and are expected to 45.5% of the total electricity supply in 2010.

	1978	1987	1996	2000	2005	2010
Power Generation(GWh)	2,324	39,314	73,924	100,510	132,960	186,000
Share of Total(%)	7.4	53.1	36.0	37.5	38.9	45.5

< Table 5-32 > Nuclear Power Generation by Year

Korea surpassed the cumulative total of 500TWh generated by nuclear power plants in February 1995, a monumental achievement contributing to economic development and environmental preservation. It would have taken 180 million tons of anthracite or 120 million tons of oil to produce that much power if these fuels had been used.

In accordance with the nation's long-term electricity demand and supply plan, which was finalized in December 1995, generators No. 3 and 4 of the Ulchin Nuclear Power Plant, generators No. 2, 3, and 4 of the Wolsong Nuclear Power Plant and generators No. 5 and 6 of the Yongkwang Nuclear Power Plant are under construction. Under the same plan, generators No. 5 and 6 of the Ulchin Nuclear Power Plant are scheduled to be built for dedication in 2003 and 2004, respectively, and eight more units are planned to be located at three different sites, which are yet to be chosen.

In 2010, nuclear power plants will account for 33.1% of the total power generation facilities in Korea as compared with 26.9% in 1996. In terms of electricity produced, Korea will depend on nuclear reactors for 38.9% in 2005 and for 45.5% in 2010.

Korea will continue promoting environment-friendly nuclear power generation to meet the ever-increasing demand for electricity in the course of economic development and the improvement of the nation's living standard. Nuclear power generation also helps Korea to raise its degree of self-reliance in the supply of electricity.

	1978	1987	1996	2000	2005	2010
Power Generation(MW)	587	5,715	9,616	13,716	18,716	26,329
Share of Total(%)	8.5	30.1	26.9	26.0	27.5	33.1

< Table 5-33 > Nuclear Power Plant Construction Plan

1.6.3. Contribution to CO_2 Reduction

As stated above, nuclear power plants represented 26.9% of the total power generation facilities in 1996 and will reach 33.1% in 2010, which would mean a drastic reduction of carbon dioxide emissions.

The cumulative total of electricity generated by nuclear power plants is expected to reach 1,760TWh during the 1997-2010 period, thus there will be reduced carbon dioxide emissions of about 520 million tons as compared with that which coal-fired power plants would emit if they were to generate the same amount of electricity.

1.7. LNG as a Clean Energy

1.7.1. Demand for and Supply of LNG

Demand for LNG began in earnest in 1987 and has since expanded at an average annual rate of 20%. Consumption of LNG is expected to continue increasing until the early 2000s, as the Government maintains its focus on setting up a nationwide distribution pipeline network.

	1987	1990	1993	1996	Average Annual Growth Rate(%)	
					1988-1990	1991-1996
City Gas	75	575	1,847	4,561	97.2	41.2
Power Generation	1,537	1,741	2,518	4,622	4.2	17.7
Total	1,612	2,316	4,365	9,183	13.0	25.8

< Table 5-34 > Trend of LNG Consumption (Unit : thousand tons)

	1997	2001	2006	2010	Average Annual Growth Rate(%)	
					1998-2001	2001-2010
City gas	7,038	10,764	14,604	17,422	11.2	5.4
Power Generation	5,970	7,280	6,500	7,200	8.4	-0.1
Total	13,008	18,004	21,104	24,622	15.9	4.0

< Table 5-35 > Mid- and Long-Term LNG Demand Projection

1.7.2. LNG Supply Facilities

The distribution pipeline network for supplying LNG across the country was expanded from 242 km as of the end of 1990 to 1,309 km by the end of 1996, and is expected to reach 2,313 km by the year 2006. Meanwhile, the construction of LNG receiving terminals, which began with just one such facility with three 100,000-kiloliter storage tanks in 1987, included two receiving terminals having 10 storage tanks at 1996 year-end. By the year 2010, a total of three large-scale receiving terminals with 53 storage tanks are planned to be in operation.

	1987	1996	2010
Number of Storage Tanks	3	10	53
Number of Receiving Terminals	1	2	3

< Table 5-36 > LNG Terminals and Storage Tanks

Note: Capacity of a storage tank is 100,000 ? .

A total of US$2.96 billion had been invested through the end of 1996 in construction projects for the supply of LNG country-wide, and another US$6.51 billion will be invested by the year 2010 for expanding the distribution pipeline network and building receiving terminals.

	1996	1997-2010	Total
Receiving Terminals	1,309.0	4,530.5	5,839.5
Distribution Pipelines	1,207.8	1,007.2	2,215.0
Total	25,168	55,377	80,545

< Table 5-37 > Investment in LNG Facilities
(Unit: billion Won)

1.7.3. Requirement for LNG Use

Since 1988, the Government mandated the use of clean energy in areas where pollution is above, or likely to be above, the regulated standard based on the Environment Conservation Act. Currently, in large cities including Seoul, Pusan and Taegu, buildings with a boiler capacity of more than 0.2 ton, apartment complexes larger than 59.5m sup 2 , and power plants are required to use LNG. This requirement will be expanded to six metropolitan areas and 18 small and medium-sized cities from September 1998.

1.7.4. Plan for Boosting the Ownership of CNG Vehicles

The Government is promoting CNG as a fuel for motor vehicles since it emits much less CO_2, CO, HC than gasoline and generates much less smog and NOx than diesel fuel.

The development of CNG motor vehicles started in 1991. From 1996-1998, sixty CNG motor vehicles will be in service in restricted areas on a pilot basis. The service area for CNG vehicles will include 21 cities, six metropolises and industrial areas from 1998-2001.

The Government will concentrate on the development of CNG vehicles as substitutes for medium- and large-size vehicles equipped with diesel engines. After 2001, more than 700,000 CNG motor vehicles will be in service.

	Stage 1	Stage 2	Stage 3
Period	1996~ 1998	1998~ 2001	after 2001
Objective	Pilot Basis	Dissemination Period	Common Usage
Area, Number of CNG Motor Vehicles	7 Areas, 60	21 Cities, 150,000	Nationwide, 700,000

< Table 5-38 > Phased Plan for Promoting CNG Vehicle Ownership

1.7.5. Promotion of Gas-fired Air Conditioner Use

The Government has encouraged installation of gas-fired air conditioners to reduce electricity consumption in summer and the to mitigate seasonal gap in LNG demand. The Government provides financial support for gas air conditioner installation. Buildings larger than specified in related regulations are required to install gas air conditioners.

	1993	1994	1995	1996	1997.7	total
Number of Buildings with Gas Fired Air Conditioners	1,869	494	543	550	308	3,764
Capacity (thousand RT)	511	128	153	164	93	1,049
Substitution Effects for Power (thousand kW)	230	58	69	74	42	473

< Table 5-39 > Ownership of Gas-fired Air Conditioners

1.8. Expansion of LPG Consumption

1.8.1. LPG (Receiving) Terminal

Currently, Korea's two LPG (receiving) terminals have a combined capacity of 420,000 tons. They are located in Ulsan and Yeochun. New terminals with a combined capacity of 430,000 tons will be constructed in Incheon and Pyongtaek by 1999 to secure a stable supply

of LPG, which is a more environment-friendly energy sources than coal.

The Pyongtaek receiving terminal, which will have a 190,000 ton capacity, will start operation from March 1999. The construction of Incheon terminal with a 240,000 ton capacity will be completed by December 1999.

1.8.2. LPG for Motor Vehicles

LPG was introduced as fuel for taxicabs in 1972 based on the Petroleum Business Act. and Its use was expanded to trucks as the Government promoted LPG as an automotive fuel. The Government relaxed the relevant regulations to allow a large number of LPG supply stations to be built.

The Government aims to mitigate environmental pollution and diversify fuel sources with the use of LPG which produces less greenhouse gas, SOx and smoke than gasoline or diesel. According to a 1994 study by the TNO Road-Vehicle Research Institute, automobiles using LPG emit 13% less CO2 than automobiles using gasoline.

LPG consumption as an automotive fuel has increased at an annual rate of 10.0% from 1987 to 1990 and 7.2% from 1990 to 1996.

1987	1990	1993	1996	Average Annual Growth Rate (%)	
				1988-1990	1991-1996
777	1,036	1,195	1,581	10.0	7.2

< Table 5-40 > Trend of LPG Consumption as Automotive Fuel (Unit : thousand tons)

1.8.3. LPG as Household Fuel

The main household fuels in Korea were coal and oil until the mid 1980s. A Dramatic switch to LPG occurred in the late '80s as most households came to use LPG or CNG. In 1996, the gas dissemination rate reached 98.2%. The construction of national LNG pipelines has promoted the usage of LNG instead of LPG. However, use of LPG as a household fuel is expected to increase steadily mainly in small cities and in rural areas where LNG is not yet available.

1987	1990	1993	1996	Average Annual Growth Rate (%)	
				1988-1990	1991-1996
871	1,595	2,147	2,378	22.3	6.9

< Table 5-41 > Trend of LPG Consumption as Household Fuel
(Unit: thousand tons)

1.9. Rationalization of Coal Industry

1.9.1. Background

Demand for domestically produced anthracite, at one time the major household fuel in Korea, began to decrease after peaking in 1986, as the people showed a growing preference for cleaner fuels such as gasoline, LNG, etc. as a result of an improved standard of living. In addition, because of a growing awareness of environmental pollution caused by anthracite, policymakers became concerned with its use as a household fuel.

In 1989, the Government began to encourage the reduced production of anthracite and the closure of coal mines based on the Coal Business Act. The public concern about pollution from the use of anthracite has also increased.

As a result, the Government has intensified its policy to reduce the production of coal, extending support to those who comply with this policy. The Government also enacted the Special Act for supporting the development of the areas surrounding closed mines in 1995.

1.9.2. Support for the Closure of Coal Mines

The Government has offered support to offset a portion of the losses incurred in the closure of coal mines and for the welfare of out-of-work miners, who if left unprotected would likely face social and economic problems.

The Government also took steps for the protection of those who closed their coal mines, and for the reforestation of areas where there had been coal mines. A total of 387.6 billion Won was spent by the Government for these purposes during the period 1989 to 1996. Over this period, the number of coal mines was reduced from about 347 in 1988 to 11 in 1996.

	1988	1990	1992	1994	1995	1996
Number of Mines	347	215	115	45	27	11
Production (thousand tons)	24,295	17,217	11,970	7,438	5,720	4,951

< Table 5-42 > Trend of Coal Production(Unit: thousand tons)

The share of anthracite in total energy consumption fell from 16.5% in 1988 to 1.5% in 1996. The significance of anthracite in the nation's energy resource mix is now minimal.

	1994	1995	1996	Total
Amount	106	366	229	702

< Table 5-43 > Support for Closed Mines (Unit: billion won)

1.10. Adoption of Low-Sulphur Standards for Petroleum Products

The Government strengthened its regulations on the sulfur content in diesel fuel from 1.0% prior to 1981 to 0.4% in 1981 and to 0.2% in 1993. In fact, as of July 1997, all areas in Korea were subject to regulations which call for sulfur levels of less than 0.1%.

Another regulation limiting sulfur levels in Bunker C oil to 1.0% is in effect in 42 districts. Furthermore, this two regulation will be enforced country-wide from July 1998. At the same time, regulations for limiting sulfur content to under 1.0% for Bunker-B were reduced to 0.5% in selected parts of the country from July 1997.

Regulations on gasoline for automobiles will also be upgraded so that they are comparable to those in advanced countries by the year 2000, while the sulfur content for diesel fuel will be reduced further to 0.05% sometime in 1998.

1.11. Installation of Emission Abatement Facilities in Power Plants

The Government has mandated the installation of emission abatement facilities in power plants and strengthened emission standards by power generation source to reduce

environmental pollutants. Th SOx emissions should be reduced to less than 1,200 - 1,650 ppm in anthracite coal plants, and to less than 500 ppm in bituminous plants by 1998. From 1999, these emissions should be reduced to less than 150-700 ppm and 150-270 ppm for existing plants and to less than 120 ppm for new plants.

	Fuel	1995- 1998		after 1999	
		Existing Plants	New Plants	Existing Plants	New Plants
SO_x (ppm)	Anthracite Bituminous Heavy Oil	1,200~ 1,650 500 1,200	120	150~ 700 150~ 270 150~ 180	120
Dust (mg/s?)	Coal Heavy Oil	100~ 200 60~ 200		50~ 150 40~ 150	

< Table 5-44 > Emission Standards Regulation

The seven-year plan (1995-2001) calls for the installation of FGD (flue gas desulphurization) facilities, dust collectors, and waste water sites. The plan involves an investment of 2,035 billion Won.

	SO_x	Dust	NO_x	Waste Water	Others
Facility	Flue Gas Desulphurization Facility	Dust Collector	Low NO_X Burner	Waste Water Site	Waste Burner Measuring Equipment etc.
Investment	1,714.4	220.8	50.8	32.34	17.2

< Table 5-45 > Abatement Facilities and Investment (Unit: billion won)

1.12. Establishment of Environment-Friendly Industrial Structure

The Government enacted a law related to the promotion of environment-friendly industry in 1995. It is fully committed to developing environment-friendly policies in regard to industrial development, including the establishment of standards for energy and industrial water consumption, and mandatory recycling for various sectors and product categories, as well as encouraging companies to develop their own plans to cope with the changing industrial and global environment.

	1996	1997	Total
R&D on Clean Production Technology Development	40	120	160
Investment in Clean Production and Environmental Facilities	320	452	772
Total	360	572	932

< Table 5-46 > Financial Support for Environment-Friendly Industry
(Unit: billion won)

Another major focus of Government policy will be to help develop cleaner production technologies and supportive measures for such activities to not only reduce pollution but improve productivity as well. Such efforts will be particularly essential in businesses involved with dyeing, plating and heat-treatment. The Government will establish a center for providing information and support for the development of clean manufacturing technologies for the benefit of small-size companies.

A civic headquarters for the promotion of environment-friendly management has been established at the Korea Chamber of Commerce and Industry for conducting educational courses and related promotional activities. Industrial companies, meanwhile, are adopting environment-friendly management practices in recognition of the launching of the ISO 14001 certification system, and the Government is offering financial and tax incentives to those who qualify for such certification.

2. Forestry Sector

2.1. Policies for Protection and Conservation of Existing Forests

To maintain and enhance a quality of natural environment, policies for protection and conservation of existing forests are fundamental. Included in these policies are forest planning system, designation of reserve and protected forests, and control of forest fires,

disease, and pests as required by the Forest Law.

2.1.1. Forest Planning System

To achieve forest sustainability through efficient management, the Forest Law provides for a forest planning system which regulates various management practices including reforestation, silvicultural practices, harvesting, and disease and pest control. Ten-year forest plans at the national, regional, and operational level are established every decade. The preparation of private forest management plans is fully subsidized by the government and in most cases, commissioned through Forestry Cooperatives, a specialized forest management organization. These plans play an important role in sustainable management of carbon sink sources. Private forests managed under the forest plans take priority in governmental assistance through subsidies, loans, and various tax systems.

2.1.2. Designation of Forest Reserves

In Korea, the forest reserve system was established to restrict conversion of forests to other uses, especially for maintaining and enhancing timber production and other public benefits. Forest reserves are essential for the conservation of carbon sinks and accounted for 77% (almost 5 million ha) of total forests in 1996.

2.1.3. Designation of Protected Forests

Protected forests are designated to conserve the forest ecosystems and to enhance environmental benefits including recreation and watershed. Timber harvesting is restricted to maintain the maximum amount of carbon sinks. These regions include natural parks, protected forests for public benefit, wildlife habitats, and natural ecosystem reserves. They accounted for 23% (1.5 million ha) of all forest land in Korea in 1996.

2.1.4. Control of Forest Fires, Diseases, and Pests

Forest fires eliminate carbon sink and immediately discharge greenhouse gases into the atmosphere. In Korea, most forest fires are caused by carelessness. Prevention activities including campaigns are emphasized, and facilities for early detection, prevention, and

control have been reinforced through advanced equipment including helicopters and operation of specialized fire control forces. In fire-damaged areas, reforestation projects are immediately initiated under governmental assistance including subsidies covering all reforestation costs.

Forest diseases and pests reduce growth and result in reduced capacity of absorbing carbon dioxide, even in deceased stock, which emits carbon dioxide. In Korea, active control measures against various diseases and pests have been undertaken. In private forests, total control costs for control of major diseases and pests are subsidized by the government, and 90% of reforestation costs are in damaged and degraded areas.

2.1.5. Acid Rain Damage Control

To monitor forest degradation by acid rain, survey systems have been strengthened through enlargement of plots being surveyed at various stages, and the establishment of advanced monitoring systems is in progress. Research on predicting acid rain damage, rehabilitation techniques and various projects to recover damaged forests are underway. To strengthen cooperation among countries in Northeast Asia for the control of acid rain damage, several joint research projects are being undertaken.

2.1.6. Prevention of Erosion and Rehabilitation of Deforested Lands

Preventive erosion control projects have been undertaken in areas which are vulnerable to landslides on a yearly basis. Since 1997, such projects have also emphasized landscape enhancement in communities in mountainous areas which are vulnerable to landslides. The development of a computer-aided erosion control plan and mechanized technology is also being emphasized. Forestry Cooperatives is initiating a specialized forest engineering group.

2.1.7. Promotion of Forestation Conservation Campaign

Traditional and unique forest-related characteristics are being identified to promote forests as cultural assets for the general public. Also environmental education is focusing on the importance of forests, and understanding of conservation is being enhanced through direct contact with forests.

2.1.8. Strengthening International Cooperation for the Conservation of Global Forests

Various ongoing forest-related issues, such as reduced forested lands, sustainable forest management, internationalization of environmental values of forests, conservation and management of biological diversity, and forest policies, are being emphasized to achieve more effective results. The possibility of support for and participation in the World Commission on Forests and Sustainable Development will be explored and Korea, as a member of the OECD, will increase its forest-related assistance to developing countries.

2.1.9. Strengthening of Research for Forest Environments

Evaluation of the public benefits of forests has been undertaken continuously. Korea will continue to develop new technologies for protection and management of forests with strengthened policies and extended organizations and manpower.

2.2. Policy Measures for Enhancing Carbon Pool

2.2.1. Afforestation

In Korea, the Government encourages the conversion of abandoned crop land in rural areas into forests. When crop land is converted, subsidies for costs ranging from 90% to 100% of the total are provided. Afforestation for pollution prevention and noise reduction are also encouraged in urban areas.

2.2.2. Reforestation with Superior Species

Forests mainly consisting of species with low growth can be cut and reforested with superior species to create larger amounts of carbon in the long term. In Korea, reforestation has been actively undertaken to convert natural forests with inferior species to plantation forests to achieve greater potential of carbon sink. Ninety percent of total reforestation costs in private forests are subsidized by the Government.

2.2.3. Policy Measures for Silvicultural Practices

To enhance biomass, various silvicultural practices such as removing shrubs and vines, and fertilization are actively pursued. Forests being tended accounted for 240,000 ha in 1996. In private forests, 80% of costs for silvicultural practices are subsidized by the Government.

2.2.4. Improving Timber Utilization

Timber plays an important role in carbon reservoir and demand for timber is increasing continuously in Korea. To increase the carbon storage capacity, new policies on improved utilization of timber, like multiple uses for small-size timber and timber treatment for increased longevity of wooden products, are being pursued.

In addition to the above policies, to increase public benefits including the role of carbon sinks and to develop forest resources, development funds with loan rates of 3%, significantly lower than current bank rates, as well as tax breaks, including income and inheritance taxes, are provided to support reforestation and silvicultural practices.

3. Agriculture and Animal Husbandry Sector

3.1. Agricultural Sector

The Korean Government has been conducting and recommending agricultural policies and practices to mitigate GHG emissions from the agricultural sector.

3.1.1. Recommending Effective Agricultural Practices for Mitigating Methane Emissions from Rice Paddies.

An improved incorporation method using organic materials involves incorporation of rice straw or compost. Incorporation of rice straw into rice paddies in autumn reduces methane emissions by 27%, and using rice straw compost instead of rice straw reduces methane

emissions by 38.5% compared to incorporation of rice straw just before transplanting. The number of rice paddies using these agricultural practices is increasing.

When chemical nitrogen fertilizer is added to rice paddies, entire layer application is recommended. Deep layer application of nitrogenous fertilizer, instead of surface application, reduces methane emission by about 50% on average over the growing season compared to unfertilized rice paddies.

During the rice growing season, methane emissions have been reduced through water management techniques like intermittent flooding and mid-summer drainage, which are effective in mitigating reduced soil redox potential to oxidized states. Ninety-one percent of rice paddies are managed with intermittent flooding, contributing to mitigation of methane emissions by 52.1% in paddies with compost incorporation and by 45.6% in rice paddies with rice straw added just before transplanting.

The Korean Government is trying to decrease the area of transplanted rice and to increase that of directly seeded rice. For direct seeding on dry paddies, where rice straw was incorporated one month before seeding and managed with intermittent flooding after emergence, methane emissions were reduced by more than 50% compared to transplanting. The cultivated area of direct seeding in dry paddies reached 57,200 ha in 1997. There are plans to increase cultivated areas of direct seeding in dry paddies to 500,000 ha by 2004. It is expected that a more than 30% reduction of methane emissions from rice paddies, even in presently cultivated rice paddies, will be maintained.

3.1.2. Promotion of Low Level Methane Emission Rice Cultivars

As it has been observed that certain rice cultivars have achieved low methane emissions, a phased development scheme has been set up. The first step is to select the rice cultivars low in methane emissions from among the recommended cultivars. The second step is to study the characteristics of the selected cultivars. The third step is to adopt development plans for the rice varieties contributing to methane mitigation. Plans for rice varieties with lower methane emissions and superior characteristics like greater productivity are already being established and put into practice.

3.1.3. Education and Information Diffusion on Methane Mitigation Measures for Rice Paddies

Technical propagation projects to reduce methane emissions of rice paddies have been

carried out aggressively by the Rural Development Administration with technical education, public information and on-site demonstration. Technical bulletins for rice cultivation include agricultural practices for GHG mitigation. Winter education and training programs for farmers also include agricultural practices for GHG mitigation. Newly developed agricultural practices effective in GHG mitigation will also be disseminated via agricultural magazines.

3.2. Livestock

The Korean Government is proceeding with strategies to mitigate methane production from livestock.

3.2.1. Methane Emission Mitigation by Enteric Fermentation

Methane production by enteric fermentation is the result of normal fermentation and animal digestion and contributes a large share of atmospheric methane. Ruminants are the biggest producers of methane among animals.

1) Determination of Number of Animals Causing Environmental Pollution

As the result of a WTO agreement, the number of livestock animals in Korea is expected to decline. The Korean Government also advises farmers to maintain only a reasonable number of animals to meet their income needs as well as to achieve abatement of methane.

2) Feeding High Quality Roughage and Improving Feed Value of Low Quality Roughage

When ruminants are fed good quality roughage, it reduces environmental pollution and improves animal performance.

The Korean Government is preparing a policy to encourage farmers to utilize pasture and idle paddy fields during winter, which produce high quality roughage.

3) Improvement of Animal Performance

Improvement of animal performance can increase methane emission per head but it can decrease methane emission per unit. The Korean Government is considering nutritional approaches such as improved formula feed and feed additives.

4) Inhibition of Methane Producing Bacteria by Adding Chemicals

In an ongoing research project, it has been found that methane production by enteric fermentation can be possibly reduced by adding sodium nitrate, ionophore or lipids.

3.2.2. Methane Emission Mitigation by Manure Management

1) Improvement of Animal Barn Facilities

Methane production from manure mostly comes from barns, manure storage and treatment facilities and manure-spread pasture. Methane production can be reduced by using saw-dust. If saw-dust is used in free stall barns as bedding, and manure is kept in storage facilities in a solid state and fermented completely by aerobes, it can be spread on pastures without methane emission. The Korean Government is considering strategies to stabilize the demand and supply of saw-dust and to find substitute materials.

2) Development of a New Manure Management System for Reducing Methane Emission.

When water pollution from animal manure drew greater public attention, a private company developed a new manure treatment system. This system is now recommended by the Government.

4. Waste Sector

4.1. Present Status of Waste Generation

The generation of waste decreased from 1991 to 1993, but has increased steadily since 1993. The amount of industrial waste (IW) has rapidly increased and began to outweigh that of municipal waste (MW) in 1993. Municipal waste gradually decreased from 1.3kg/day/person in 1994 to 1.1kg/day/person in 1995.

Item		1991	1992	1993	1994	1995	1996
Total		158	144	141	147	148	180
Municipal Waste		92	75	62	58	47	50
Industrial Solid Waste	Total	66	69	78	88	100	130
	General	47	48	55	85	95	125
	Specific	18	21	22	3	4	5
Daily Generation Rate of Municipal Waste per Capita(kg)		2.3	1.8	1.5	1.3	1.1	1.1

< Table 5-47 > Annual Amount of Waste Generation (unit: thousand Ton/d)

Data: Ministry of Environment (MOE), Environmental Quality in Korea, 1997

4.2. Policy Direction for Waste Management

The final objective of waste management in Korea is to reduce the burden waste places on the environment, thereby conserving nature and allowing people to live under environmentally pleasant conditions. Rather than simply treating wastes, it has become necessary to introduce an innovative system of resource recycling to conserve the natural habitat to be shared with future generations.

Therefore, waste minimization policies in Korea have been considered as more important than any other. We believe in the generally-accepted hierarchy if solid waste management: preventing and/or reducing the generation of waste at its source; improving the guidelines for waste disposal, such as reducing related hazards; and encouraging re-use, recycling and recovery.

The National Plan for Comprehensive Waste Management is based on this concept.

Waste Type	Year	Recycling	Incineration	Landfill
MSW	1995	23.7	4.0	72.3
	1998	30.0	15.0	55.0
	2001	35.0	20.0	45.0
ISW	1995	61.2	6.3	32.0
	1998	65.0	10.0	25.0
	2001	68.0	12.0	20.0

< Table 5-48 > National Targets for Solid Waste Management (unit :%)

Data : MOE, Environmental Quality in Korea, 1997

4.3. Policies for Waste Reduction

The primary objective of waste management policies is to minimize waste at the source. Current policies are briefly explained in the following section.

4.3.1. Reduction at Production Stage

1) Reduction of Industrial Waste

The Waste Management Act was revised in August 1995 to incorporate the reduction of industrial waste. Present regulations emphasize improving production processes and recycling waste in order to reduce waste as a by-product of production. The Act applies to companies generating hazardous wastes of over 200 ton/yr. The number of companies falling under the law are about 600 in four fields. Although this number accounts for only about 1%

of total companies generating hazardous industrial waste, these 600 companies generate over 86% of the total hazardous waste.

2) Product Charge System

The product charge system was implemented by the "Act Related to Promotion of Saving and Reutilization of Resources" of July 1993. Under the system, environmental costs of products and raw materials which involve difficulties in collection and recycling are incorporated into their final product prices. As a result, the environmental costs are distributed equally and products are managed in an environmentally sound way. Items covered by this system are 28 items of 10 products including bottles of insecticides and other items containing hazardous substances.

4.3.2. Reduction at Distribution Stage

The "Act Related to Promotion of Saving and Reutilization of Resources" and the "Detailed Enforcement Regulation on Packaging Methods and Materials" emphasize avoiding unnecessary packaging and replacing disposable packing materials with reusable or easily recyclable ones. Also, excessive packing is regulated by the ratio of the space occupied by the product to the total package and the number of wrappings. PVC and other EPS packaging materials are discouraged.

Packaging waste has increased annually at an average rate of 7.0% and accounts for 32% of total municipal solid wastes. The use of plastic packing materials is increasing steadily, and they are projected to exceed 23% of total package wastes in 2001.

4.3.3. Reduction at Consumption Stage

1) Volume-based Waste Fee System

The Volume-based Waste Fee System was introduced nationally on January 1, 1995, to reduce municipal wastes and stimulate recycling programs (Table 5-4). Unlike a flat collection fee, unit fees vary according to the volume of solid wastes generated.

According to statistics from 16 cities and provinces, since the introduction of the system, solid municipal waste has decreased by 29.4% (49,191 ton/d to 34,726 ton/day), while recyclable increased by 28.5% (8,927 ton/day to 11,468 ton/day).

The daily generation rate of municipal waste was reduced to 1.01kg/person (Table 5-4).

Item	Reduction Rate in Waste (%)	Increase Rate of Recyclables (%)	Daily Generation Rate of Waste (kg/person)
Average	29.4	28.5	1.01
Large-size Cities	24.9	33.2	1.10
Provinces	35.6	22.6	0.90

< Table 5-49 > Outcome of Volume-based Waste Fee System

Data : MOE, Environmental Quality in Korea, 1997

2) Reduction of Food Wastes

The per capita generation rate of food waste is a reduction to 0.27kg/day and the rate of the amount to be recycled is an increase to over 21%. To achieve these targets, the generation of food waste must be reduced at all stages including production, distribution, and consumption.

Item		Unit	1993	1995	1996
MW	Generation	Ton/d	62,940	47,774	46,194
	Generation per capita	Ton/d/person	1.48	1.07	1.01
Food Waste	Generation	Ton/d	19,764	15,075	16,260
	Generation per capita	Ton/d/person	0.46	0.34	0.35
	Percent in total wastes	%	31.4	31.6	35.2

< Table 5-50 > Trend of Food Waste Generation

Data : MOE, Environmental Quality in Korea, 1997

Those specifically required to reduce food waste were identified as restaurants serving over 100 persons per day and/or restaurants with service areas larger than 100sq. m. These restaurants should reduce foot waste moisture content to below 75% and/or recycle food waste by producing animal foods and/or composting. Also, the central government will financially support local, city, and provincial governments' construction of recycling facilities for food waste.

3) Discouragement of Disposable Products

As disposable products (cups, forks, razors, etc.) are widely used because of their convenience, quantities have increased dramatically. The use of such products is not encouraged and restaurants, commercial bath houses, and accommodations are discouraged from freely supplying them to customers as specified in the Act Related to Promotion of Saving and Reutilization of Resources.

4.3.4. Reduction at Disposal Stage

1) Establishment of Separation/Collection System

Although the separation/collection system is more widely accepted now, its results are insufficient to minimize the generation of solid waste. It is necessary to clarify the role and responsibility of each participant in the separation, collection, and transportation of solid waste process. In addition, local governments need to establish efficient separation/collection plans and set up achievable recycling targets.

2) Development of Various Treatment Technologies

The Korean Government plans to reduce landfill waste and increase the incineration rate. According to the National Plan, the use of landfills for municipal waste should decrease from 72.3% in 1995 to 45% in 2001. Meanwhile, the incineration rate of municipal waste should increase from 4.0% in 1995 to 20% in 2001. Presently, most methane gas generated from landfills is emitted into the atmosphere without treatment. According to a Korean Government plan, all landfill sites will be sanitary landfills by 2001. The generated methane will be recovered to be used as fuel or incinerated to reduce the greenhouse effect.

Incineration technology should also be developed to meet the huge demand for incineration plants which are to be constructed in the near future (Table 5-6). In the case of small-scale incineration facilities, it is possible to design and manufacture them using domestic technology. Large-scale incinerators, however, have been constructed with the help of advanced incineration technology from developed countries. Based on technical agreements with developed nations, current proposals are to develop domestic technology to construct large-scale incineration plants. Also, the Korean Government is strongly supporting recycling technology which converts food waste into valuable resources and municipal solid wastes into compost.

Item		Total	Yearly Investment			
			Until 1995	1996	1997	After 1998
Investment	Total	11,315	395	178	624	10,118
	Financing Subsidy	10,742 573	- 395	- 178	624 -	10,118 -
Incineration Plants		52	9	2	1	40

< Table 5-51 > Construction Plans of Incineration Plants for Municipal Solid Wastes (unit : 100 million won)

Source : MOE, Environmental Quality in Korea, 1997

It is expected that greenhouse gases generated from landfills would greatly decrease as a result of the introduction of a variety of technological treatments and effective management policies for solid wastes.

4.4. Waste Recycling

It is expected in Korea that paper, scrap iron, plastics, scrap tires, lubricants, scrap electronic products and furniture are to be recycled because of their high rate of disposal. The distribution and consumption of these goods are also significant. Relatively high market values are received for these recycled products.

4.4.1. Separation/Collection System for Recyclables

The five classes ? paper, scrap iron, glass, cans and plastics ? in the separation/collection system make it simple for high-rise apartment residents to separate items. Two or four classes of recyclable in the separation/collection system are available in other residential areas. Recyclable bottles are identified by an imprinted mark, leading to easy separation, collection, and recycling.

4.4.2. Deposit Refund System for Acceleration of Recycling

The objective of the deposit system is to accelerate recycling. Manufacturers and/or importers are required to deposit the recovery and collection cost of products which are generated in high quantities but easily recyclable. The deposit is returned to the manufacturers and importers according to recycling records. Presently, 12 products from six categories are controlled under

the deposit system.

4.4.3. Enhancement of Recyclability of Products

Car and electronics manufacturers and/or importers producing over certain quantities are legislatively classified as category one companies. Evaluation of their progress regarding structure and raw materials of products in terms of recyclability during the course of the production process is required. Category one companies are required to improve structures and materials for easy disposal and recycling.

4.4.4. Establishment of Regional Recycling Zones

The nation is divided into five regional recycling zones: Sudo, Chungcheong, Honam, Kyungnam, and Donghae. The regional zones should maintain storage centers for recyclables. The main role of the storage centers is to control the demand/supply of recyclables along with collection and recovery of them within the regions. The Korea Resource Recycling Corporation (KRRC) also participates in the collection of recyclables generated from some regions which are avoided by private companies because of economic viability. In addition, the KRRC maintains intermediate processing facilities for recyclables to improve their quality. Presently, the KRRC plays an important role in offering information on recycling technology and regional demand/supply. Information centers are now established to keep the process working smoothly.

4.4.5. Acceleration of Recycling through Manufacturer and Government Cooperation

The Government encourages establishment of co-operative systems among similar manufacturing industries to share the same recovery and sales system for wastes. Also, standard recovery methods are used to recover by-products generated during the course of production through cooperation between manufacturers and government. It is necessary to develop a policy for recycled products to be purchased primarily by the Government, resulting in market expansion for recycled products.

4.4.6. Expansion of Recycling Industries and Public Recycling Facilities

In order to increase the number of industries which re-use materials and produce recyclable products, it is necessary to support them financially from a special fund to improve the environment (15 billion Won in 1995). Also, these companies are offered loans on a first priority basis from an industry base fund made up of funds for small and medium-size companies and from a fund for pollution prevention. A variety of policies are being pursued to support companies which recycle. Among these policies are installation of public storage facilities for recyclable materials within greenbelt regions, financial support of small companies using recycling technology, special support of companies using first-class technology and management techniques, and inducements to create investment by the private sector in specific fields of advanced technology.

4.4.7. Utilization of Recycled Waste

It is mandatory for some companies, including paper mills and glass, plastic and steel manufacturers, to re-use waste as a raw material to some extent.

Recyclables		Until 1995	1996~ 1997	From 1998
Paper		47	50	55
Glass		42	47	52
Steel cans		20	30	40
Plastics	PET	10	25	55
	Others	5	10	20

< Table 5-52 > Target Utilization Rates for Recyclables by Sector (unit : %)

Data: MOE, Environmental Quality in Korea, 1997

4.4.8. Recycled Products Marketing

The mandatory purchase of Environment Ministry-designated recycled products has been expanded to include 114 public agencies, including central and local governments, government-invested institutes, etc. The number of mandatory recycled products to be purchased has been expanded to 24 items, including 14 storable products (e.g., solid soap)

and 10 non-storable products (e.g., slag cement from high-temperature furnaces).

4.5. Industrial Wastewater Management

4.5.1. Management of Industrial Wastewater Sources

Wastewater generated from industrial complexes is managed by the Office of Environmental Management, and that from other sources is managed by local governments.

Central monitoring teams from the Ministry of Environment were formed to support the local monitoring systems. In 1996, wastewater generated from 1,621 factories was investigated. It was reported that 287 companies had violated discharge standards.

Depending on the type of wastewater treatment system and to what degree companies violate the standards, they are assigned blue, green, yellow, and red color codes and are managed separately. This tiered management system was introduced to encourage self-regulated management and appropriate management of each wastewater treatment system. Industries are classified into one of five groups ? ranked first to fifth-based on the quantity of wastewater produced.

The number of regular checks conducted are according to the company's ranking.

4.5.2. Consignment of Wastewater Treatment

Since August 1987, professional wastewater treatment companies have been consigned to treat wastewater discharge rates of lower than $10m^3$/day. Also, the wastewater should be treatable by physical treatment methods. In cases where the physical and chemical composition of wastewater varies significantly, professional wastewater treatment companies also can be used. The quantity of wastewater treated by professional treatment companies reached $508,000m^3$ in 1995 and $467,000m^3$ in 1996. The Water Quality Preservation Act was revised in January 1996 to apply the same regulations to other facilities which generate wastewater (e.g., incineration plants, drying facilities, condensation facilities, etc.).

5. Transportation Sector

Energy consumption in the transportation sector has increased. The number of motor vehicles in Korea has increased by over one million per year since 1990 so that resulting energy consumption and air pollution have become serious problems. Facing huge energy consumption and CO2 emission increases, the Korean Government has carried out and promoted a number of policies to reduce greenhouse gases in the transportation sector.

5.1. Policy to Reduce Exhaust Gas Emissions from Motor Vehicles

5.1.1. Strengthening Exhaust Gas Emissions Standards

Exhaust gas emissions standards for motor vehicles were first introduced with the implementation decree of the Environment Conservation Law in June 1978, which was revised ten times since, including the amendment of the implementation regulation of the Air Quality Preservation Act in September 1996.

In accordance with the amendment of implementation regulations in March 1995 to limit exhaust gas emissions from 3-ton and heavier vehicles fueled by gasoline and to promote development of low-emission engines, emissions standards for city-buses involving NOx

and particle materials are strengthened in 1998. In 2000, the emissions standards for heavy duty vehicles are also strengthened to the equivalent level of developed countries. In the September 1996 amendment, emissions standards effective in 1998-2000 are strengthened to the level of developed countries for all vehicles: large-sized diesel vehicle emissions standards are strengthened from 25% to 40% beginning in 1998; jeeps and 8-passenger vans, which formerly were classified as small-sized cargo vehicles, are reclassified as passenger cars; and passenger vehicle emissions standards for NOx are strengthened from 0.62g/km to 0.40g/km.

5.1.2. Recall System Improvement

The recall system, practiced in only four countries (Korea, the USA, Canada, and Sweden), requires an inspection/test of in-use vehicles to determine if the emissions standards are being maintained during the emission warranty period. Korea introduced the recall system in 1992. In addition, the amendment of September 1996 requires recall inspections to be divided into preliminary and main segments so that fairness of the inspection system is guaranteed.

5.1.3. Strengthening Emission Warranty Period

In February 1991, when the Air Quality Preservation Act was introduced, the emission warranty periods were distinguished according to fuel and vehicle type, and the warrantees were extended in stages so that gas-fueled vehicles which came with 100,000-km warranties until 1995 had warrantees of 120,000 km from 1996.

In the September 1996 amendment, light-duty truck 40,000-km warranties in 1996 were extended to 60,000-km for 1998, and to either five years or 80,000-km from 2000, the same warranty periods as for passenger cars.

5.1.4. Promoting Motor Vehicle Fuel Quality

As a measure to reduce emissions from diesel vehicles, since July 1990, Korea began to produce and commercialize vehicles with passenger capacities of 15 or less operated by LNG or LPG instead of gasoline and diesel. There were 234,000 such vehicles, including sub-compact cars, as of December 1996.

Since 1991, Korea has strengthened support of research for CNG (Compressed Natural

Gas) bi-fuel systems and will start their distribution from 2000. To develop and distribute electrical hybrid cars, road testing will begin in 1999 and commercialization will be pursued thereafter.

5.1.5. Market Promotion of Buses Equipped with High-powered Engines

To prevent city-buses from emitting gases due to a lack of power, high-power buses, upgraded from 185 horsepower to 230 horsepower, were introduced from 1991. The entire bus fleet will be powered by 230 horsepower engines from 1999.

5.2. Policy Measures for Reducing Emissions from Vehicles in Operation

5.2.1. Strengthening Gas Emissions Standards

Gas emissions standards can be divided into regulated items and regulated standards by type of fuel or class of vehicle. Regulated items are CO and HC (Hydrocarbon) in gas and LPG-fueled vehicles, and exhaust pollution in diesel-fueled vehicles. Emissions standards for exhaust pollution have been strengthened from 40% to 30% levels for large diesel vehicles made after 1996, and to the levels of 25% and less for local buses from 1998.

5.2.2. Development of Diesel Particulate Traps

To remove pollution from exhaust emissions, diesel particulate traps have been developed using purification technology since 1992. In February 1996, the Ministry of Environment announced standards for test equipment and test methods, and designated test centers to conduct official assessments.

Wide dissemination of diesel particulate traps is encouraged by exemption from environment improvement surcharges and from road inspections.

5.2.3. Introduction of I/M Program

In December 1995, the Air Quality Preservation Act was revised to introduce periodic

emissions testing at designated test centers. Standards were tightened by the addition of the A/F test in Seoul from 1997 (nationwide from 1998). Testing is being changed from an unloaded test to a loaded test and a NOx test will be added soon.

5.3. Strengthening Fuel Quality Standards

Prior to 1992, manufacturing standards for motor vehicle fuel and additives regulated the concentration of lead and phosphorus. Since 1993, aromatic benzene and the amount of oxygen are also being regulated step-by-step.

Sulphur concentration in diesel fuel was regulated at 0.4% and below prior to 1992, 0.2% and below in 1993, 0.1% and below in 1996, and will be 0.05% and below from 1998.

5.4. Demand Management for Motor Vehicles

5.4.1. Energy-Savings and Pollution Mitigation through Vehicle Usage Limitation

The Government is to undertake energy saving policies in transport sector, which will result in GHG emissions reductions. In an effort to bring about voluntary cutback on the frequency of, in large part wastefull, motor vehicle usage the Government will not only maintain gasoline and diesel fuel prices at appropriate levels, but also reform the current tax system into a more environmently friendly one.

5.4.2. Expansion of Public Transportation Modes

The energy efficiency of public transportation is much higher than that of personal transportation. Thus, greater use of public transportation will reduce energy consumption and enhance the abatement of vehicle emissions.

1) Expansion of Subway lines

The No. 1 line of the first Seoul Subway network began operation in August 1974, No. 2 line followed in May 1984 and No. 3 and 4 lines in 1985. This network is 118 km long and connects the north, center and south of Seoul. In the second subway network, consisting of Number 5, 6, 7, 8 lines, No. 5 line, the north section of No. 7 line, and No. 8 line were completed in December 1996 for a total length of 100.4 km. The construction of Number 6

line, the south section of Number 7 line and the extension of Number 8 line will be completed in 1999 (total length 61.5 km).

City		Length(?)	Construction Period
Total		261.6	-
	sub-total	145.0	-
Seoul	<2nd network 2-1>	83.5	
	No. 5 line	52.0	1990~ 1996
	North section of No. 7 line	16.0	?
	No. 8 line	15.5	?
	<2nd network 2-2>	61.5	1994~ 1998
	No. 6 line	31.0	?
	South section of No. 7 line	26.0	?
	Amsa section of No. 8 line	4.5	?
Pusan	No. 2 line	39.1	1991~ 1998
Taegu	No. 1 line	28.3	1991~ 1997
	No. 2 line	24.6	1995~ 2000
Incheon	No. 1 line	24.6	1993~ 1999

<Table 5-53 > Current Status of Subway Construction

In Pusan, No. 1 line started service in June 1994 and the Number 2 and 3 lines are currently under construction. No. 1 line and No. 2 line of the Taegu subway system will be completed in 1998 and 2002, respectively. No. 1 line of the Incheon subway system will be complected in 1999. Additionally, the first lines in Gwangju and Taejun will be completed after 2003.

2) Construction of Light Rail Transit

The Light Rail Transit networks in metropolitan areas like Seoul and Pusan (89 km long and including six lines) will be completed by 2003. The network, to be extended to 221 km and include 13 lines, will be completed in phases during 2004-2011.

3) Encouragement of City Bus Use

The bus-only lane, which is in effect on roads which have more than three lanes one way, currently supports more than 150 buses/hour. This traffic is being lowered to more than 100 buses/hour. Bus arrival on-line information systems, transmitting traffic information to bus

stops, are being developed.

The Government plans to provide stable bus service by amending the "Vehicle Transportation Act." Also, it will support the construction of common garages for city buses.

4) Reduction of Demand for Personal Transportation

To reduce unnecessary use of motor vehicles, the Government is increasing the price of gasoline and diesel fuel. By raising taxes on vehicle use and implementing a traffic congestion charge, the Government will promote the use of public transportation.

The Government is reviewing a "Weekend Vehicle Operation System" and plans to encourage bicycle-riding, ride-sharing, etc.

6 Integration of Environmental and Economic Policies

1. Economic Development and the Environment

1.1. Environment-Friendly Economic Development

1.1.1. Establishment of Strategic Environmental Planning

The Master Plan for the Preservation of the Natural Environment (1994-2003) aims at striking a balance between protection of nature and development. In 1995, the "Green Vision 21" document presented Korea's ten-year environmental policy goals. The major goal of Green Vision 21 is to improve the quality of life by harmonizing preservation and development within the limits of the nation's environmental resources, with the benefits accruing to this generation and succeeding ones.

1.1.2. Change of Production and Consumption Patterns

Korean consumers with high incomes are likely to step up levels of consumption, buying more and bigger cars, and using more water and recreational services. However, they are also becoming increasingly aware of environmental implications as living standards rise. The Government is trying to stimulate this consciousness with programs like the Korean Eco-Labelling System and by levying charges on environmentally damaging products.

1.2. Economic Effects of Environmental Policies

1.2.1. Environmental Expenditures

Total public expenditure by government, including local government, grew 24% from 1992-1995, reaching 8,218 billion Won. These figures include expenditures for water supply and investment in nature protection. Total public expenditures in 1995 were about 1% of GDP, excluding expenditures for water supply and investment in conservation of nature.

Revenues from the emissions charge and the environmental quality improvement charge are credited to the Special Account for Environmental Improvement, which was established to make allocation of environmental resources more efficient.

Category		1992	1993	1994	1995
Total Expenditure		6,621	6,818	7,354	8,218
By Level of Government					
	Central	604	631	903	1,503
	Metropolitan Areas and Provinces	2,739	2,552	2,481	2,582
	Cities and Counties	3,278	3,634	3,964	4,133
By Environmental Medium					
	Water Quality	1,583	1,682	2,429	2,627
	Water Resources	3,286	3,286	3,207	3,605
	Waste	963	991	1,100	1,326
	Air Quality	22	20	19	124
	Nature and Soil	459	480	440	392
	Technology and Other	309	357	160	144

< Table 6-1 > Environment-related Expenditure in Public Sector(1992~1995)
(Unit: billion Won)

Note : 1995 prices were used.
Source: Ministry of Environment.

1.2.2. Competitiveness and Eco-industry

The Korean eco-industry began when environmental problems became apparent in the latter 1970s and developed parallel to overall industrial growth in the 1980s. More than 10,000 environmental firms are estimated to be active in Korea, and their number is growing at an annual rate of 7%. The eco-industry covers 17 fields including toxic substance remediation, waste recycling and anti-pollution equipment installation. The domestic market for environmental products was estimated at 4,000 billion Won in 1994 and is growing rapidly with increased investment in anti-pollution equipment due to strengthened environmental standards and steady economic growth.

2. Instruments for Policy Implementation

2.1. Regulations

The major instruments are environmental standards, emission limits and the designation of special zones.

Most of the country's waters have been assigned a quality class. Emission limits have been also specified for a number of substances (33 for water, 26 for air). Permits are required for atmospheric emissions and discharges into water. Separate limits have been set for specific installations such as sewage treatment stations and large stationary combustion sources.

In addition, various types of special zones, like water supply source areas and dust pollution control zones, exist. Depending on the type of zone, certain activities are prohibited, and both environmental standards and emission limits are made more stringent.

2.2. Economic Incentives

2.2.1. Environmental Charges

Korea's first use of economic instruments in environmental policy dates from 1983 when the emission charge system was put into effect. If permit holders are detected violating

specified conditions, the system imposes charges on emissions of certain pollutants in excess of set limits. Ten air pollutants, includingSOx, and 15 water pollutants, including BOD, COD and suspended solids, are subject to this charge.

Category	1991	1992	1993	1994	1995	1996
Amount Imposed (100 million Won)	222	104	128	161	157	119
No. of cases	3,815	3,099	3,808	4,267	3,544	3,190

< Table 6-2 > Imposed Amount of Emission Surcharges

Source : Environment White Book, 1997, Ministry of Environment.

The emission charge system was modified with an economic incentive policy in 1997, encouraging enterprises to reduce emissions to below the allowable level.

The environmental improvement charge to induce superior energy efficiency, introduced in 1991, is targeted at owners of commercial buildings whose floor area exceeds 160m^2 and diesel-powered vehicles.

	1993	1994	1995	1996
Amount Imposed (100 million Won)	399	893	1,256	1,784
No. of cases	225	4,109	4,544	5,527

< Table 6-3 > Amount of Environmental Charges Imposed

Source : Environment White Book, 1997, Ministry of Environment.

A waste disposal charge system was introduced in 1993 to deal with waste not covered by the deposit-refund system. The goal is to promote waste reduction and resource conservation. Producers and importers are charged for materials and products that are difficult to collect or recycle.

2.2.2. Deposit-refund System

A deposit-refund system for disposal of beverage containers was put into effect in 1992. The Government is planning to adjust the deposit rate to create more incentive for producer

treatment and recycling.

2.2.3. Financial Support

Central government financial support to local governments is primarily for water supply, waste water and solid waste treatment. The overall amount covers 30% to 70% of investment costs. Government support to industry consists of tax exemptions and long-term, low-interest loans to establish facilities to prevent, treat or recycle pollutants, or to develop related technologies.

2.2.4. Integration of Environmental Concerns in Financial Policy

Tax deductions are provided to certain companies involved in environmental conservation and also given for investment in anti-pollution facilities and for waste recycling. Taxes on gasoline, light oil, cars and electronics products are considered to have a beneficial environmental side-effect.

2.3. Other Instruments for Policy Integration

2.3.1. Land Use Planning and Environmental Impact Assessments

The 1977 Environment Conservation Act first introduced the requirement of environmental impact assessments for the development of urban projects, industrial sites and energy projects. The 1993 Environmental Impact Assessment Act increased the types and number of projects subject to the environmental impact assessment, and added public consultation procedures and provisions to ensure consultation results are incorporated in the project.

2.3.2. Public Information and Participation, Role of NGOs

The Ministry of Environment is engaged in raising citizens' environmental awareness through development of environmental courses in schools and publication of environmental statistics, including administrative ones like enforcement.

Environmental non-governmental organizations (NGOs) play an important role in educating and informing the public. About 200 NGOs carry out various campaigns on a local or national scale. The Government also provides limited financial support for environmental

NGOs.

2.3.3. Dispute Settlement

To permit prompt and fair compensation in the amount of actual damage to the health and property of citizens caused by pollution, the 1990 Environmental Dispute Settlement Act (revised in 1995) provides for settlement of conflicts.

2.3.4. Consumer Information and Market Structure

To direct consumer attention towards products that are less polluting or more energy efficient and to encourage manufacturers to adopt environment-friendly production and distribution processes, the Government has undertaken a number of initiatives. In 1992, for example, a voluntary eco-labelling program was initiated. A government-industry-consumer committee, the Korean Environmental Labelling Association, selects products to carry the eco-label.

In 1994, the Act for Promoting an Environment-Friendly Production System was adopted. It provides the establishment of a clean technology development support center.

In addition, the Environment-Friendly Plant Certification System was introduced to promote environment-friendly management. Plants listed under this system receive special benefits, such as exemption from acquiring a permit from environmental authorities prior to adding or modifying an installation, exemption from inspection, and access to low-interest loans.

2.3.5. Role of Private Enterprises

Korean industries are preparing to establish ISO 14000 environmental management systems, and some have their own internal environmental audit systems, and guidelines and criteria for environmental action. Their environmental targets are sometimes more stringent than government regulations.

7 Impact of Climate Change on the Korean Peninsula

1. Overview

Considering the potential pervasive effects of climate change, the Korean Government supports basic research related to risk assessment of climate change. The most comprehensive study was done by the Korean Institute of Science and Technology (KIST) and other research groups from 1993-1994. The study analyzed the impact of climate change on the ecosystem, agriculture, forestry, the ocean, hydrology, etc.

Detailed risk assessment studies have been carried out based on climate change scenario studies of the Korean Peninsula. The study analyzed the case of the doubling of carbon dioxide around the Korean Peninsula. The report will contribute to the evaluation of regional effects and the establishment of regional adaptation policies.

2. Anticipated Climate Changes

This study formulated five major general-circulation-model simulations of the Korean Peninsula. The results were analyzed to predict possible temperature changes due to a doubling of carbon dioxide.

It is predicted that temperatures will increase by 1.0-4.0℃, with a probable range expected to be between 2.0℃ and 2.5℃. As for regional and seasonal distributions, North Korea and the East Sea coast will have greater temperature changes than midwest coastal areas. Temperature change during winter will be greater than summer.

Three scenarios were also proposed to show the effects of rainfall on the Korean Peninsula, based on equations coupling results of synoptic rainfall distribution in general-circulation-model simulations with the distribution of regional rainfall on the Korean Peninsula. Scenarios assume an increase of 15% and 20% of annual rainfall as well as

negligible change in rainfall, respectively. The most likely scenario is a 15% increase.

Summer-time variability is expected to be greater than annual average variability. Rainfall changes during winter are also expected to be less than during summer.

3. Impact on Water Resources

Climate changes cause variations in soil moisture and water resources. The most important factor responsible is regional rainfall. The study analyzed past rainfall and river flow data based on Korean Peninsula temperature and rainfall change prediction scenarios reported by the Meteorological Research Institute.

The calculated regional outflow varies significantly depending on the scenario. With a 15% increase in rainfall, considered to be a representative scenario, the study estimates Han River flow would increase 28%, Nakdong river 23%, Geum River 23%, Youngsan River 24%, and Sumjin River 26%, resulting in an average increase in flow of up to 25%. The potential for heavy flood damage increases in the summer due to increased river flow.

It is expected that rainfall will increase with climate change. The general- circulation-model predictions, however, indicate great variability during summer rainfall, ranging from -25% to +30%. Such rainfall could cause catastrophic drought and floods.

Adaptation strategies for drastic drought would be needed along with modifications to the design of water resource facilities and a revision of the comprehensive long-term water resource plan.

4. Impact on Agriculture and Crop Growing

Under the condition that other environmental factors are constant, except temperature (rising higher than current levels), the study predicted changes in agricultural climate zones and for crop growth periods.

Such changes were studied using various agricultural climate sources and sample cases of

temperatures increasing 2C to 4 C, relative to the present. Results show the growing season would increase from its current 210-280 days to 220-320 days at 2C and to 230-340 days at 4 C. In the latter case, the southern coastal areas and the lower southern regions would become a subtropical climate zone experiencing almost no winter. The nation's central region would see a climate similar to current southern coastal areas. Thus, wheat and barley, which need winter fallow and now grow in the southern half,could be expected to be grown further north.

It is expected for rice cultivation that an average increase of 2C would result in the possibility of growing pseudo-late-season cultivar or late-season cultivar across the Korean Peninsula. Growth of mid-season cultivar could occur in the cold, high altitudes of the Taebaek mountain range. Problems due to low temperatures during growing seasons would be reduced considerably. As the time needed to vegetate reaches 190-200 days in the southern coastal regions, it would be possible to introduce a multiple cropping system.

Latent crop productivity should increase for the year due to the lengthening of summer by a maximum of 60 days. However, this only applies in a very limited fashion to dominant crops that would enjoy these new conditions. In the current ecosystem, pure "first level" productivity would decrease due to exaggerated high temperature conditions and the explosive demand for evapotranspiration that would follow. It would be difficult to maintain normal levels of production for perennial temperate zone fruit like apples, grapes, pears and peaches because of the significant turbulence expected to the natural ecosystem.

There are too many hidden dangers from global warming on crop productivity in a temperate climate zone like Korea to state simply a lengthening in the growing season will occur due to temperature rise. Accelerated global environmental change should rather be an accepted factor toward deterring or damaging agricultural ecosystem stability, and it would be preferable to formulate active response measures.

5. Impact on Vegetation

Three different climate scenarios, i.e., rises of ₽ , 2? , and 4? of annual average temperature due to a doubling of atmospheric carbon dioxide, were assumed, and changes in

the growth distribution patterns of vegetation were projected. Growth distribution of semi-temperate zone vegetation (eg., camellia tree) would increase with a 2? rise in annual average temperature and temperate zone and semi-boreal zone vegetation would decrease exponentially.

Changes to the forestry growth pattern in central temperate zones were analyzed with a scenario of a doubling of carbon dioxide after 80 years, accompanied by a 2 rise. Predictions are that decline of forests would start approximately 30 years after climate change began and severe damage would occur after 100 years.

Therefore, to maintain and improve development of forestry resources continuously and to maintain the ecosystem, it is imperative to formulate a plan to develop forestry planting and growth technology for each respective species.

6. Impact on Sea Level, Coastline and Coastal Structure

The Korean coastline consists of about 12,000km, including artificial coastline (13% of total). Coastal waters below 20m of altitude are extensively used. Coastal areas usually are characterized by high population and vigorous economy. Such areas are very sensitive to environmental impacts. A certain sea level rise would result in many problems, especially for the southern and western coastal areas, and destroy the ecosystem. Therefore, it is important to relocate basic structures and industries and to establish harmony between environment and industry.

7. Impact on Marine Products

If seawater temperature off the Korean Peninsula rises, the most significant impact will be on cold-water fish. There are "water masses" in summer, cold during the winter season, along the deepest caves in the Yellow Sea which provide habitat for cold-water fish like codfish. In cases that the "cold-water masses" are extinguished before the summer season and that the cold-water masses are not formed because of the stream of the Kurilian Current

becoming more rapid, cold-water fish could become extinct in the Yellow Sea.

Since it is not certain if temperature rise in surface water directly causes temperature rise in the lowest-depth water, it is difficult to know whether bottom- or middle-depth cold-water fish are sustainable. Habitat of cold-water fish like salmon and herring would likely move northward. Moreover, middle-depth cold-water fish like the Alaska pollack and codfish would disappear from Korea's waters if no "cold-water masses" flowed from the north. Warm-water fish from the East China Sea would move to seas off the Korean Peninsula, providing habitat for mackerel, pike, sardine, etc.

8 Research and Observation

1. Research

1.1 Basic Research for National Communication

Korea is a signatory of the Climate Change Agreement of October 1993. Under Korea's commitment as a member country of the Agreement, Korea Energy Economics Institute (KEEI) has been designated to conduct basic research, investigating and presenting national statistics on greenhouse gas emissions like CO_2.

1.1.1. Objectives

The research done by the Korea Energy Economics Institute had four objectives:

- report in detail national statistics on greenhouse gas emissions and absorption,
- analyze potential influences of global warming on Korea,
- research national policies for establishing a cost-effective plan to reduce greenhouse gases, and
- establish a plan to minimize the economic burden and contribute to national growth.

1.1.2. Scope

Research was conducted in social sciences and natural sciences for two years, 1994 and 1995.

First, on the basis of studies by IPCC and Korean specialists, this research investigated characteristics of greenhouse gases, and established the scale and scope of statistics. It classified greenhouse gases into two categories, main and other. The main category includes CO_2, methane, and NOx while the other category consists of CO, SOx, and CFCs. It analyzed the main sources of such gas emissions.

Second, it evaluated social and economic activities which influence greenhouse gas

emissions. In the first year, it evaluated the roles of energy, industry, transportation, agriculture, forestry, waste, land-use, and air and ocean in greenhouse gas emissions.

Third, it estimated the quantity of emissions and absorption of greenhouse gases in Korea. It used formal IPCC methodology to examine and measure emissions from various energy sources and economic activities, including agriculture and farming sectors.

Fourth, it evaluated the effects of climate change on the Korean Peninsula. It investigated the expected influence of doubling CO_2 density on natural and biological systems.

Fifth, it analyzed policy instruments like energy taxes, for possible reduction of greenhouse gas emissions.

Sixth, based upon the above evaluations and analyses, it recommended mid- and long-term policies for the reduction of greenhouse gas emissions.

1.2. Basic National Energy Plan

In 1996, Korea conducted research for the establishment of the ten-year National Energy Plan (1997-2006) on the basis of the Rationalization of Energy Utilization Act.

1.2.1. Objective

The objective of the research was to provide policy goals and strategies on energy supply and demand to ensure economic growth, minimization of environmental costs resulting from energy consumption, efficient energy use and improvement of energy-related technologies.

The National Energy Plan provides principles and directions for other energy-related plans regarding energy sources and sectors. Its research extends to all energy-related fields.

1.2.2. Scope and Scale

The research to establish the National Energy Plan included the analysis of trends and a forecast of international and domestic energy supply and demand in order to achieve a reliable energy supply. Through the evaluation procedure of previous policies, it also provided some policy issues related to energy conservation and improvement of energy efficiency, and development and promotion of efficient technology. Specifically, this research focused on setting up national policies in the context of minimizing environmental

costs from energy use in all sectors.

1.3. Action Plan for Climate Change Mitigation

To establish an action plan for climate change abatement including introduction of new strategies and fortification of existing policies, Korea is conducting a project from 1997 through 1999.

1.3.1. Objective

This project is to produce a cost-effective action plan for mid- and long-term energy, economic, and environmental policies, which is a national plan following the Climate Change Agreement.

1.3.2. Scope

In the first year of the project, the procedures include refinement and expansion of statistics for greenhouse gas emissions, development and preliminary operation of a model for analyzing reduction of greenhouse gases, establishment of a database to analyze greenhouse gas reduction, and case studies of developed countries' action plans.

1997	1998	1999
- Expanding Statistics of Greenhouse Gas Emissions - Development and Preliminary Operation of Model Analyzing Reduction of Greenhouse Gases - Establishment of Database For Analysis of Greenhouse Gas Reduction - Analysis of Action Plans of Developed Countries	- Forecast of Mid- and Long-Term Emissions of Greenhouse Gases - Analysis of Potential Reductions - Analysis of Preference of Potential Reductions - Analysis of International Cooperation - Analysis of Legal/Juridical Systems for Implementation of Action Plan - Analysis of Administration	- Re-Establishment of Reduction Goals and Analysis of Potential Reductions - Start-Up of Preferred Reductions - Establishment of Action Plans by Sector - Enforcement Regulations - International Cooperation

< Table 8-1 > Planned Research Projects for the Action Plan for Climate Change Mitigation

In the second year, 1998, this research will incorporate these aspects: forecast of mid- and long-term emissions from greenhouse gases, analysis of potential reductions, analysis of

preference of potential reductions, analysis of joint implementation, analysis of legal/juridical systems and an administration system to implement the plan.

In the third year, 1999, the following five topics are included: re-establishment of reduction goals and analysis of potential reductions, derivation of preferred reductions, establishment of an action plan by sector, enforcement regulations, and international cooperation.

1.4. Plans for Development of Environmental Technology

In order to develop long-range and systematic environmental technology to carry out the government's environmental policy and to improve the national welfare, the Korean Government established a ten-year plan for the development of environmental technology in 1992. This plan laid out the strategies to progress from the current technology level to advanced technologies of developed countries. It includes investment of 974.7 billion Won (public investment - 792.7 billion Won, private investment - 182 billion Won) from 1992 through 2001.

Environmental technology will contribute to mitigation of climate change. In particular, "climate change forecasting technology" and "technological development to utilize CO_2" will be essential for mitigation of climate change.

The Korean Government arranged a one-year project (May 1996 to April 1997) to devise a long-range plan for environmental technological development to resolve domestic environmental problems, to respond to new international environmental regulations, and to contribute directly to solving world environmental problems in the next century.

The plan's primary objective was to meet the demand in the domestic environmental technology market necessary to improving new environmental technology and enforcing environmental standards, which could be realized by encouraging technological development by new businesses. In addition, this plan provided responses to international efforts to link environment and trade and proposed that the environmental technology industry be developed as an export industry in the 21st century.

It included a ten-year environmental technology development plan, along with the existing G-7 environmental engineering technology development project. The total amount of

investment for environmental engineering technology development in 1996 was 74.4 billion Won, which was equal to 0.019% of GNP. This figure represents an increase of 39.3% compared with the size of investment in the previous year.

Project	Total	Year					
		1992	1993	1994	1995	1996	1997-2001
Total	9,747	98	312	479	628	927	7,303
G-7 Project	4,315 (1,820)	66 (27)	189 (102)	301 (172)	382 (216)	553 (307)	2,824 (996)
Basic Technological Development	912	14	29	33	38	68	730
Supportive Technological Development	4,520	18	94	145	208	306	3,749

< Table 8-2 > Current and Planned Annual Investment for Environment Technology Development

Private Investment (in parentheses)
Source: Environmental White Paper, 1997, Ministry of Environment.

The ratio of public investment for environmental technology to total government R&D investment was 3.13%. Among OECD countries in 1992, this figure ranges from 0.7% to 3.6%. Compared to OECD members, it places Korea in the higher investment group. However, total investment is much lower than that of OECD countries.

The Korean Government plans to raise the ratio of environmental R&D to total government R&D investment up to 5% by 2001. The third stage of the G-7 project will be completed at that time. In 1997, the government established a Long-range Plan for Environmental Technology Development, which promotes consumer-oriented and advanced environmental technology development.

	Environmental Technology R&D Investment by Government(A) (billion won)	GNP(B) (billion won)	A/B (%)
1991	54	2,142,399	0.003
1992	109	2,387,046	0.005
1993	184	2,655,179	0.007
1994	494	3,037,726	0.016
1995	534	3,489,790	0.015
1996	744	3,734,819	0.019

< Table 8-3 > Annual Environment Technology R&D Investment per GNP

Source: Environmental White Paper, 1997, Ministry of Environment

1.5. G-7 Environmental Engineering Technology Development Projects

Since 1992, the Korean Government has used the advanced technology development project (G-7 project) to raise its technological development close to G-7-country standards.

This ten-year plan is divided into three stages. In the first stage (1992-1994), the project focused on obtaining and developing basic environmental technology. In the second stage (1995-1997), it focused on development of core technology and practical establishment of technology. In the third stage (1998-2001), the project focuses on utilization, commercialization, and exportation of the technologies. The results of the project is analyzed and evaluated every year.

From 1992 to 2001, public and private investment in this field will total 249.5 billion Won and 182 billion Won, respectively. Investment will yield three core technologies each in the areas of global environment, air quality, water quality, waste, and treatment.

From November 1992 to November 1996, the G-7 environmental engineering technology development projects attracted public and private investment of 66.7 billion and 82.4 billion Won, respectively, focusing on 23 core projects like desulphurization, denitrozation, clean-water, anti-pollution technology, etc.

	1st Stage (1992-1994)	2nd Stage (1995-1997)	3rd Stage (1998-2001)
Goal	Obtaining Basic Technology	Utilization and Establishment of Core Technology	Utilization, Commercialization and Establishment of General Environmental Management System
Technology Development	Pollution Mitigation Technology Development		Treatment Technology, Recycling Technology
Industry	Independent Development of Environmental Technology		Exportation of Environmental Technology

< Table 8-4 > Goals of G-7 Environmental Engineering Technology Development Projects

	Total	1992-1996	1997	1998-2001
Total	4,315	1,491	530	2,294
Government	2,495	667	237	1,591
Private	1,820	824	293	703

< Table 8-5 > Current and Planned Investment for G-7 Environmental Engineering Technology Development (100million Won)

The Korean Government will not only extend and strengthen the current G-7 projects, but it will also promote systematic and long-range environmental technology development projects to address current environmental problems.

1.6 Promotion of Basic and Fundamental Environmental Technology Development Projects

Since 1996, Korea has promoted the Basic and Fundamental Environmental Technology Development Project and the G-7 project to deal with recent growing demands for environmental technology.

This project requires public research and development and full-scale investigation, which private companies have some difficulties in conducting but which are necessary for the commercialization and utilization of environmental technology.

Year	1996	1997	1998	1999	2000	2001	Total
Investment	5	5	4.5	15	20	20	69.5

< Table 8-6 > Annual Investment Plan for Fundamental Environment Technology Development Projects (Unit: 100 Million Won)

1.7 Climate Change Forecasting Technology Research

The Korean Government has added a new research area, "monitoring global change and development of climate change forecasting technology," to the G-7 projects. From the second stage of the G-7 projects, this new research area has been modified to "climate change forecasting technology."

While this research continues, Korea is actively participating in GCTE (Global Change and Terrestrial Ecosystem), LUCC (Land Use and Cover Change), IGBP, which includes AMIP (Atmospheric Models Intercomparison Project), PMIP (Paleoclimate Modeling Intercomparison Project), and CMIP (Coupled Models Intercomparison Project), and START/TEACOM.

In the "Atmosphere/Ocean GCM Development" project, Korea is verifying atmosphere GCM through analysis and inspection of Asian monsoon and global water cycles, and developing new oceanic GCM including a surface mixed layer grid model for oceans. The oceanic GCM model successfully simulates climate change and the ElNino phenomenon.

This project involves research on global and regional climate change due to greenhouse gas emissions. Through atmospheric GCM developments including investigating the stratosphere, the ozone effects from the multi-dispersion of sunlight and relationship between clouds and solar radiation can be estimated.

Korea also plans to study annual changes in the stratospheric cycle and analyze the ancient climate model project to describe climate patterns on the Korean Peninsula from 6,000 years ago.

The "Regional Climate Model" project reflects summer monsoons in East Asia and classifies 13 plant groups. This model separates East Asia into nine regions, analyzing Pan-

Asia monsoons, and enables analysts to model climate changes around the Korea Peninsula.

Also, data and information related to global warming is classified systematically and provided on the Internet as modeled data.

1.8. Greenhouse Gas Control Technology Research

After 1992, the Advanced Technology Development Project (a G-7 project) promoted chemical and biological technology to control amounts of CO_2, which accounts for 55% of global warming. This technology changes hydrogenized CO_2 through catalysts to methanol or combined hydrocarbons, and uses low-quality hydrocarbons to develop highly activated catalysts for useful combinations.

By introducing combined catalysts containing methanol, acid, and metal, this research raises the CO_2 transformation rate from 12.5% to 33%, and develops transformation of CO. Also being developed is production of liquid screening for CO_2 separation and production technology of screening for separating high temperature gas. A water-swollen-hydrogel screen of high molecular complex, which is economical in energy consumption, is being developed as well.

1.9. Research Related to the Climate Change Convention

	Title	Year
Korea Energy Economics Institute	Policy measures for energy sector to combat global warming	1992
	Policy measures for energy sector regarding the Climate Change Convention	1993
	Mid- to long-term policies for reinforcing demand side management	1993
	Institutional measures for facilitating the expansion of new and renewable sources of energy	1994
	Study on UNFCCC National Communication	1994-95
	Development of a model for the evaluation of energy conservation policies	1995
	Basic National Energy Plan	1996
	Economic assessment of energy efficiency management system	1996
	Action plans for the Climate Change Convention	1997-99
	Facilitating the use of energy from waste	1997
	Economic analysis of energy/carbon tax with a dynamic general equilibrium model	1997

< Table 8-7 > List of Researches Related to the Climate Change Convention (cont'd)

	Title	Year
R&D Management Center for Energy and Resources	Development of solar thermoelectric cogeneration system	1995-97
	Development of the waste plasted pyrolysis process	1995-97
	Basic technology development for IGCC (Integrated Gasification Combined Cycle)	1995
	Development of photovoltaic-wind power hybrid system for the electrification of mono-electrified rural areas	1996
	Study on the high efficiency compound solar cell	1996
	Development of the fuel cell system	1996
	Separation and fixation of CO_2 by the formation of claxrates	1996-97
	Formation of clean fuel for the internal combustion engine from CO_2	1996-97
Korea Institute of Science and Technology (KIST)	A Study on Strategy And R&D Policy Measures to Address Global Warming	1991
	Studies on Potential Effects of Climate Change on Korea and Strategic Measures for Global Environment	1993-94
Korea Institute of Energy Research (KIER)	A Study on the Technological Strategy to Improve the Global Environment in the Energy Field	1996
Science and Technology Policy Institute (STEPI)	Future Comprehensive plan for Environment Research in Korea	1994

2. Observation

2.1. Climate Change Monitoring System

The Korean Government makes synoptic and other meteorological observations. These include not only surface weather observation, upper air observation, and marine meteorological observation but also aeronautical meteorology, satellite meteorology, radar observation, lightning, background air monitoring, earthquake monitoring, etc.

Since the climate monitoring network expansion project was initiated in 1993, the Korean Government has introduced and operated the following climate monitoring equipment: non-dispersive infrared analyser for atmospheric CO_2 concentration, gas chromatography for CH_4, N_2O, and CFCs and ozonesonde systems for vertical ozone distribution over Korea. In 1995, an atmospheric Particle Counter and UV-Biometer were imported.

In 1996, ion chromatography equipment for analyzing precipitation chemistry and an integrated air quality monitoring system for observing surface ozone and reactive gases (SO_2, NOx, CO, TSP) in the atmosphere were introduced.

	Surface	Upper Air	Satellite	Radar	Aeronautical	GAW (Global Atmospheric Watch)	Marine	Earth-quake	Lightning	AWS
Headquarters	1		1							
Regional	4		4							
Meteorological - Station	28	2	9	2	2	2				
Observatory	39		1	3	7	1				
Subtotal	72	2	15	5	9	3				
							3	12	10	400
Total								12	10	400

< Table 8-8 > Systematic Observation Network (Unit : number of units)

By 1995, the Korean Government provided climate monitoring systems which measure four greenhouse gases, CO_2, CFCs, CH_4, and N_2O, by introducing greenhouse gas

monitoring equipment.

Semi-automation of the CO_2 monitoring scheme on the basis of accumulated techniques saved costs and labor. Stratospheric ozone monitoring has been accomplished with Brewer ozone spectrophotometer by UV-Biometer.

A new GAW station was completed in 1996. Its role is to measure the background air pollution monitored under the WMO/GAW program. For this purpose, many advanced equipments such as an ion chromatography, ambient air monitoring systems, and several new laboratory instruments were introduced in 1997.

2.2. Mid- and Long-term Plan for Meteorological Technology Development

The long-term plan for meteorological technology development was established in 1994 to respond to international and domestic environmental problems. In 1997, the Korean Government also established mid-term action plans by sector. The planning period covers from 1997 to 2001.

This plan proposes modernization of meteorological equipment and structures, increases in investment and labor, international cooperation, activation of meteorological R&D, and improvement of a weather service system and weather information system.

The Korean Government will improve its meteorological information system by expanding the meteorological observation network and improve weather services by using dynamic forecasting technology.

Also, the Government will reinforce climate change monitoring and intensify research on analysis of climate change and development of forecasting technology.

2.3. Scenario Analysis of Climate Change

In 1994, the Korea Government arranged research regarding a scenario of climate change around the Korean Peninsula. The previous scenario conducted by international institutions

like IPCC could not be applied due to irregular precipitation, so new research was performed. The research examines the Korean climate and precipitation change due to increased CO_2 in the air. Analyzed data, obtained by running improved GCM from the main GCM_S used in advanced countries, were used.

The Korean Government will promote projects to expand and improve on this scenario, following biennially revised IPCC scenarios.

2.4. Participation in WMO

Korea actively participates in WCP, GCOS, GOOS, and GAW, established and operated by WMO (World Meteorological Organization), which explain the effects of global warming, El Nino, and acid rain and establish counterplans. Korea also participates in cooperative projects operated by WMO, like global energy and water cycle experimental (GEWEX), collection and analysis of data related to the interaction between atmosphere and ocean, and global monitoring for changes in temperature, sea level, sea ice, etc.

9 Enhancing Public Awareness

1. Public Relations and Education on Environmental Conservation

1.1. Public Relations (PR) on Environmental Conservation

Korea recognizes that some of the greatest contributions to environmental conservation can be made by the public. In the light of this, the Government's approach to public information campaigns on environmental conservation has been developed on two levels. The first level aims to raise public confidence in its environmental administration and to develop public awareness of environmental conservation. The second level aims to build a national competence in conservation in the 21st century by targeting the younger generations. The Government plans to achieve an efficient and systematic campaign by making full use of the mass media including TV, radio, newspapers, and the wide distribution of environmental information.

1.1.1. PR through Mass Media

The Government and its various agencies distribute reports on new environmental policies and the current environmental pollution situation to newspapers, broadcasting stations, and environmental journals. Environment-related non-governmental organizations are also included in the distribution process.

1.1.2. Public Contest on the Theme of Environmental Conservation

The Government has been holding an annual essay contest on environmental conservation since 1991. In addition, an environmental photo exhibition has been held since 1992, and has been expanded to four areas - encompassing TV campaigns, newspapers and magazines, photography and video. The winning pieces go on public exhibition to raise citizens' awareness about pollution.

	Total	1980-1981	1992	1993	1994	1995	1996
Total	43,961	17,361	4,557	5,676	5,452	5,015	5,900
Civil Servants	21,813	10,794	2,557	1,886	1,662	2,090	2,834
Professionals	22,138	6,567	2,000	3,790	3,790	2,925	3,066

< Table 9-1 > Outcome of Environmental Education (Unit : number of persons)

1.1.3. PR Materials

The Government distributes periodicals about environmental policy and related information to its affiliated institutions. The journal "Environment Information," which reports on domestic and international environmental programs, is distributed monthly, and the booklet "Establishment of a Green Environment Nation," which contains the "President's Environmental Declaration," and "Religious Leaders' Declaration of a Green Environment" were distributed to non-governmental organizations and educational institutions.

1.1.4. Appointment of Honorary Environment Monitors

Local governments have adopted an Honorary Environment Monitor System. From 1987, this system has monitored and reported on environmental pollution and has collected public opinions and promoted public awareness of environmental conservation.

The Government plans to strengthen its public information activities through all available means and measures and to introduce new campaign methods, especially those which directly reach and involve the public. The Government is also making efforts to encourage the public to voluntarily take action.

1.2. Education and Training on Environmental Conservation

The Government disseminates new technology and practical information to environment-related civil servants and technical staffs as a way of training environment experts. The general direction of training about the environment includes moral education, an understanding of environmental pollution, and the enhancement of the ability to cope with the changes of environmental policy.

1.3. Environmental Education in Schools and Local Societies

1.3.1. Environmental Education in Schools

The right to enjoy a clean environment was added to citizens' fundamental rights in the Constitution (1980). Thereafter, environmental laws have been legislated and related rules formulated.

Environmental education has been included in the curriculum of primary, middle and high schools since 1982 (the fourth notification of educational curriculum). In 1987, environmental education was included as one of the eight socially-important educational areas (the fifth notification of educational curriculum). With the sixth notification of educational curriculum (1992), environment courses like the Environment and Environmental Science were newly established in the middle school curriculum (1995) and the high school curriculum (1996), respectively. These changes resulted from society's growing awareness of environmental problems.

In higher education, an increasing number of colleges and universities have a Environment Department. In addition, international seminars on environmental education are frequently held and many books on environmental education are being published.

1.3.2. Environmental Education in Local Communities

The Government conducts statutory environmental education for civil servants and for environment managers in the private sector. In cooperation with the Interior Ministry and educational institutions, it supports environmental education institutions in the private sector. Local governments also conduct environmental education programs for honorary environment monitors and the public.

1.4. Support for Environmental Non-Governmental Organizations

Environment-related activities of non-governmental organizations include public information campaigns for environmental conservation, academic surveys and research, and seminars on environmental policies. The Government encourages public participation in decisions and implementation of environmental policies. Non-governmental organizations

are represented in the government's environment-related committees such as the central consultative body for environmental conservation. A "Policy Conference for Non-governmental Environmental Organizations " consisting of more than 20 non-governmental organizations was established to promote cooperation. The conference meets three or four times a year to discuss current environmental issues and policies. The Government also supports a variety of environmental events like "National Meetings for Green Action" on Water Day (March 22, 1996).

2. PR and Education on Energy Conservation

The Government plays a leading role in the national energy-conservation movement. It sets November as "Energy-Conservation Month" and every Friday as "Energy Conservation Day," and organizes environmental events like "Grand Meetings on Energy Conservation." The Government provides practical techniques and information on energy conservation with the help of mass media. Through TV advertisements, it emphasizes the necessity of saving energy, the relationship between energy, economy and environment (3Es), and provides practical tips.

The Government provides professional technical information to industry and holds "Energy Exhibitions" every year to promote efficient energy facilities. Additionally, it holds "Grand Meetings on Energy Conservation" every two years to inspire public awareness for saving energy.

2.1. Energy Conservation PR

2.1.1. PR through Mass Media

Regular programs in the mass media provide examples of efficient use of energy and induce improvement in energy efficiency and awareness of energy conservation. In 1996, there were 3,648 energy conservation campaigns in newspapers and magazines, 1,737 on TV, and 3,080 on radio.

2.1.2. Distribution of PR Materials and PR movies

The Government distributes energy conservation booklets, slogans, and placards to every government office, non-governmental organization and educational institution. The distribution of audio-visual materials containing examples of energy conservation policies is highly rated in raising public awareness.

2.1.3. Energy Conservation Campaign

The Government supports a public contest for excellent energy conservation examples and selected ones are widely publicized. It also gives lectures about saving energy and supports study tours to model energy conservation sites.

2.2. Energy Conservation Education

The Government implements a policy of early energy conservation education. Thirty-three schools have been designated as exemplary schools. It also has distributed educational materials to elementary and middle schools.

The number of colleges and universities having departments related to the environment is increasing. International seminars on environmental education are frequently held and professional books about environmental education are published regularly.

10 International Cooperation

1. Bilateral Cooperation

1.1. Energy Sector

Korea puts high priority on bilateral cooperation with several countries to promote energy related technology cooperation, as seen in Table 10-1.

Korea holds regular meetings with the United States, Japan, and Australia on a reciprocal basis concerning the promotion of the transfer of environmentally relevant technology. Energy technology cooperation projects with seven countries including Australia, Italy, and Russia are in progress.

Countries	Cooperation area	Current status
USA	- New and Renewable Sources of Energy - Energy Conservation	-Exchange of Agreement Notes, Faculties, and
Russia	- New and Renewable Sources of Energy - Energy Conservation	- Joint Research and Technological Cooperation, - Working Group on Technological Cooperation
Italy	- New and Renewable Sources of Energy	- Joint Workshops on New and Renewable Sources of Energy once a year
Canada	- Energy Conservation	- Exchange of Agreement Notes - Joint Seminar once a year
Australia	- Clean Energy	- Joint Seminar on Clean Energy - Joint Research
Japan	- New and Renewable Sources of Energy	- Information Exchange
China	- New and Renewable Sources of Energy	- Working Group on New and Renewable Sources of Energy - Joint Seminar once a year

< Table 10-1 > Bilateral Technology Cooperation in Energy Sector

1.2. Environmental Sector

Korea is encouraging international cooperation on exchanges of environmental information and data. The Korean-Japanese Environmental Committee, established in 1994, is conducting 31 projects including studies on the effects of industrial materials on humans and the protection of seasonal (migratory) birds. In 1987, the Ministry of the Environment of Korea and its U.S. counterpart exchanged a memorandum of understanding on environmental cooperation to conduct activities such as support of a clean water treatment team. A Korean-Chinese environmental cooperation agreement was reached in 1993 to promote 16 projects including monitoring of acid rain and joint research on the Yellow Sea environment. Korea has also signed environmental cooperation agreements with France and Canada to introduce advanced environmental technology and environment management techniques by exchanging environmental technology, data, and experts.

1.3. Meteorological Sector

After the Korean-Chinese Meteorological Cooperation Agreement in 1994, technological cooperation with China on telecommunications systems and Global Air Watch (GAW) began. The Korean-Japanese Science and Technology Cooperation Committee has yearly meetings, and the development of a weather forecast system on the Korean Peninsula is in progress in collaboration with Japan. Korea also is collaborating with Australia with the exchange of a memorandum of understanding on meteorological cooperation.

2. Multilateral Cooperation

Korea actively participates in a wide range of multilateral cooperation. It plays an active part in the activities of UNFCCC's greenhouse abatement program and also contributes funds, technology and manpower to UNEP.

2.1. UNFCCC

As a member of UNFCCC, Korea has participated in COP ? and COP ? , and subsidiary bodies, and is implementing a broad range of policies and measures to reduce greenhouse gases. In accordance with UNFCCC, the preparation of a cost-effective Korean Action Plan began in 1997.

In addition, the Asia Least Cost Greenhouse Gas Abatement (ALGAS) project is underway in collaboration with the Asian Development Bank. Twelve countries, including Korea, India, China, and Thailand, are also participating in the ALGAS project. The Korea Energy Economics Institute (KEEI) plays a key role in ALGAS research on greenhouse gas emission statistics, ways to achieve greenhouse gas abatement, and cost-effective emission abatement strategies.

Korea contributed US$5.6 million to the Global Environment Facility (GEF) in 1996-1997 to protect the global environment and will actively participate in the second GEF.

2.2. IPCC

Korea is participating in the activities of IPCC. The 9th IPCC general meeting in 1992 formed Working Group ? to evaluate socio-economic effects of and countermeasures for climate change. As a Co-chair of IPCC Working Group ? with Canada, Korea has made efforts to complete the Second Assessment and contributed to the assessment as a Lead Author. This committee is believed to be the first group to have economists and sociologists collaborate on climate change issues.

2.3. UNEP and UNDP

Korea has participated in several programs conducted by UNEP and plays an active role in the Global Environmental Monitoring System (GEMS) managed jointly by UNEP and WHO, and other cooperation programs managed by UNEP/ESCAP and PACE-E.

Korea is also participating in the Tumen River Development Project, which is one of the high priority projects in Northeast Asia cooperation.

2.4. OECD and IEA

After participation in the Environmental Policy Committee of OECD as an observer country in 1993, Korea conducted research and analysis on the applicability of environment-related laws and rules.

Korea joined the OECD in December 1996. The OECD Environmental Policy Evaluation Committee reviewed Korea's environmental policies and advised the future direction for improvement.

Korea, currently a non-voting member of the IEA, dispatches experts to IEA and participates in eight of 44 IEA programs. Korea is making efforts to join IEA as a full member country.

2.5. APEC

Korean energy experts are participating in six energy cooperation projects with APEC's Energy Working Group. Korea's cooperation with APEC includes standardization of energy efficiency, an environmental pollution monitoring system and drafting regulations on pollution emitting industries and hazardous wastes. In the second APEC Industrial Meeting, Korea proposed adoption of a minimum energy efficiency standard system among APEC member countries. This proposal gained the support from most of the member countries and was reflected in the Ministerial Declaration.

2.6. WHO

Korea contributed US$1.27 million to WHO's environmental projects. In a joint project with WHO, the Seoul International Environment Symposium was held in September 1992. Korea also provided financial assistance to the North-East Asia Conference on Environmental Cooperation (NEAC) and to workshops on assesment of environment polluting materials..

2.7. Convention to Combat Decertification (CCD)

Korea made recommendations to the CCD Secretariat for the efficient use of budgets at the Sixth CCD inter-governmental negotiation committee and contributed US$50,000 to support developing countries' participation. In the future, the Korean Government will make further financial contributions within its fiscal capability.

Korea, which has been very successful in afforestation, will offer its experience and technology through bilateral and multilateral cooperation. Cooperation with WEC/IEC, PECC/MEF is in progress.

2.8. ITTO

ITTO is currently establishing strategies for sustainable timber production in tropical countries, which will conserve carbon reservoirs in tropical forests. Korea supported ITTO with contribution of US$214,000 in 1995 and US$249,000 in 1996.

In addition to its contributions to ITTO, Korea also provided US$10,000 for a forest protection project in timber producing countries and gave additional financial support of US$100,000 to those countries in 1997.

2.9. World Commission on Forest and Sustainable Development (WCFSD)

Korea, a WFC member, has contributed US$30,000 to the organization and is actively participating in WFC activities.

2.10. World Meteorological Organization (WMO)

Korea dispatches meteorologists to the World Weather Watch Program, the World Climate Program, and other research projects of WMO. Korea will continue to participate in WMO's activities to find the causes of and to establish countermeasures for global warming,

destruction of the ozone layer, and acid rain.

2.11. Regional Environmental Cooperation

Korea maintains a close cooperative relationship with its Northeast Asian neighbors including Japan and China. It has entered environmental cooperation agreements with Japan and China to conduct joint projects with these countries. Korea hosted the second and fourth annual Northeast Asia Conference in September 1993 and September 1995. In the Northeast Asian Regional Environment Program (NEAREP), an inter-governmental negotiation meeting held by the Economic and Social Commission on Asia and the Pacific (ESCAP), cooperation projects among the Northeast Asian countries were established in the field of energy, air pollution, ecosystem management, and capacity building. The first Northwest Pacific Action meeting under UNEP was held in Seoul in September 1994. Northwest Pacific Action supports detailed ocean conservation programs.

11. Future Directions

In this National Communication, Korea has provided information on its natural environment and economic circumstances, energy consumption patterns, and inventories of greenhouse gas emissions/reservoirs. It has also forecast CO_2 emissions to 2010.

Information was given about current and future policies and measures to mitigate greenhouse gas emissions in all sectors including energy, agriculture, waste and transportation. Policies to enhance carbon dioxide gas emission uptake in the forestry sector were also discussed.

Korea reviewed its efforts concerning integrating environmental and economic policies, promoting climate change research and observation, and raising public awareness, all of which are being pursued by the Government to support the various above-mentioned policies and measures.

In recognizing the global nature of climate change, Korea is pursuing bilateral cooperation with the United States and Japan and other countries, and is also actively participating in international organizations such as UNFCCC, IEA, APEC and WMO.

To limit CO_2 emissions more effectively in the future, the Government will continue to emphasize policies that encourage voluntary participation of industry and the private sector, instead of existing policies that are regulation- and subsidy-oriented.

To this end, the Government will expand tax and financial support on the one hand, and will develop and implement measures to reduce CO_2 emissions through voluntary agreement between government and industry as in developed countries. The Government will, if necessary, take further action to enact laws promoting more effective mitigation.

The Government will also make greater efforts to enhance the awareness of industry and the general public regarding UNFCCC. The importance and impact of UNFCCC on Korea will be publicized through public forums, publication of pamphlets and guidebooks, and through the mass media.

To encourage rational energy use, education opportunities for industry and the general public will be expanded. Early education projects regarding energy use will be strengthened to enhance awareness among primary, middle and high school students, who are the future

leaders of the nation.

The Government will also encourage the industrial sector to develop plans that take into account CO_2 emission limitations in accordance with UNFCCC.

The Government will make efforts to obtain concrete outcomes from the newly introduced policies. It will also require energy suppliers to develop and carry out plans to enhance efficiency so that demand management investment can be expanded. At the same time, they will, accordingly, be encouraged to develop and implement means to minimize costs and losses incurred from those investments.

The activities of central and local governments will be coordinated so that regional energy plans can be established according to each region's unique circumstances. Support for regional energy projects will be continually expanded, and local governments will be encouraged to enhance awareness and capabilities regarding greenhouse gas issues.

Korea will take active efforts to refine and expand the scope of the next National Communication. First of all, consideration will be given to minimizing the uncertainty of the CO_2 emissions forecast and to including inventories and projections for emissions of greenhouse gases other than CO_2. In addition, mitigation policies for each greenhouse gas and by each industry will be presented, and an analysis of how each policy can contribute to abatement will also be included. Policies responding to climate change will be investigated as well.

Korea will make its best effort to mitigate and prevent climate change within its economic and social capabilities, and will strengthen bilateral and multilateral international cooperation so that these efforts can be pursued most effectively.