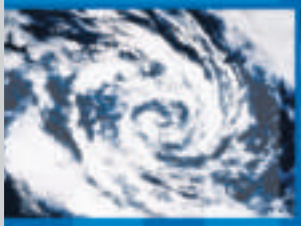
Second National Communication of the Republic of Korea Under the United Nations Framework Convention on Climate Change





The Government of the Republic of Korea

Second National Communication of the Republic of Korea Under the United Nations Framework Convention on Climate Change

This report is the second national communication of the Republic of Korea submitted to the United Nations Framework Convention on Climate Change (UNFCCC).

This report is available on the internet at : http://www.keei.re.kr.

Contents

Tables

Figures

Chapter 1 Executive Summary

Chapter 1

Executive Summary

1. National Circumstances

The Republic of Korea (hereafter Korea) comprises the southern region of the Korean Peninsula in Far East Asia. Located between 125° 04′ and 131° 52′ east longitude and between 36° 06′ and 38° 27′ north latitude, Korea covered a land area of 99,954 km^2 as of 2001, in which 65% of the land consisted of forests and 19% used as farm land. Its position in the temperate mid-latitude zone endows Korea with four distinct seasons. The annual average temperature is about 10 ~ 16°C. Summer is marked with heavy rainfall whereas there is relatively little precipitation in the winter. The variance of rainfall by season is relatively higher with annual average precipitation ranging from 1,100 ~ 1,400 mm in the central region and 1,000 ~ 1,800 mm in the southern region.

As of the end of 2001, Korea's population stood at 47.343 million showing an annual growth rate of 0.91% between 1991 and 2001 and a sex ratio of 101.4 males to 100 females. With the exception of various city-states and small countries, Korea's population density of 474 persons per square kilometer makes it the world's third most densely populated country after Bangladesh and Taiwan.

Agricultural land, of which rice paddies account-

ed for 61.1% and uplands 38.9% in 2001, has continued to diminish by an average annual of 22,000 hectares during the past decade. The reduction in farmland will gradually lessen the overall consumption of fertilizer. Nitrogenous fertilizer, which emits nitrous oxide, accounts for about 50% of the total fertilizer consumption. As for livestock, the number of livestock and poultry increased in line with the growing consumption of meat by the changing diet pattern of Koreans.

Korea has taken aggressive measures for economic development since the 1970s which prompted high year-on-year economic growth rate, attaining an average annual growth rate of 8.8% between 1986 and 1995. Rapid growth in trade has established Korea as the world's 11th largest economy. Korea's leading industries include shipbuilding, semiconductors, electronics and auto manufacturing. By 2001, agriculture, forestry and fisheries accounted for a mere 5.6% of Korea's total industrial structure, whereas the mining and manufacturing industries accounted for 39.1%, services 46.8% and construction 8.5%. The United States emerged as Korea's largest export market accounting for about 20% of total exports followed by China (12%) and Japan (11%).

Korea's GDP rose 1.7 fold to 427.3 billion dollars between 1990 and 2001 and its per capita GDP rose 1.5 fold accordingly to 9,025 dollars in 2001. However, difficulties arising from the 1997 financial crisis which precipitated a bailout loan from the International Monetary Fund (IMF), forced Korea's economy to adopt improvements to irrational systems, corporate restructuring and purging of inefficiencies in industries. Such measures have prompted a continued current account balance surplus since 1998.

Korea's primary energy consumption was estimated at 198.4 million TOE (tons oil equivalent) in 2001 ranking it the 10th largest energy consuming nation in the world. Of the total energy consumed, 97.2% was imported. Oil was the major source of energy at 50.7%, followed by coal (23.0%), nuclear energy (14.1%), LNG (10.5%), hydraulic power (0.5%) and others (1.2%). Of the total energy consumption, about 55.7% was used by industry, 21.5% by the residential and commercial sectors, 20.9% by the transportation sector and 1.92% in others including the public sector.

Rapid economic growth and increase in personal income have led to a sharp growth in the demand for transportation and the number of cars has greatly increased from 127,000 in 1970 to 12,694,000 in 2001, recording a 100-fold growth in thirty years. The number of privately owned cars showed particularly rapid growth. In the passenger transport sector, subway routes continue to expand in line with the growth of national income and the subway and domestic aviation play a greater role as important transportational modes, while maritime shipping is increasingly taking on a bigger role in the freight transport sector.

2. Greenhouse Gas Inventory

Rising energy consumption is the major cause of the increase in greenhouse gas emissions which rose 2.6% from 144.3 million tons of carbon (MtC) in 2000 to 148.0 MtC in 2001. The energy sector was a major contributor to this increase at 104.2% while industrial processes, agriculture and waste contributed -3.5%, -3.0% and 2.2%, respectively.

The trend of total greenhouse gas emissions between 1990 and 2001 indicates an annual increase of 5.2% with per capita emissions rising by 4.3% per year since 1990, recording 3.13 tons of carbon (tC) in 2001. However, the greenhouse gas intensity

〈Table 1-1〉 Major Indicators of Greenhouse Gas Emissions

Classification	1990	1995	1998	1999	2000	2001	1990~2001 Average Annual Growth Rate (%)
Total GHG Emissions (1,000tC)	84,738	123,445	123,974	135,542	144,259	148,038	5.2
Per Capita GHG Emissions (tC per Capita)	1.98	2.74	2.68	2.91	3.07	3.13	4.3
GHG/GDP (tC per Million Won, '95)	0.322	0.327	0.314	0.310	0.301	0.300	−0.6

indicated the increase seen during the early 1990s began to fall after 1996. In the energy sector, which consists of fuel combustion and fugitive emissions, greenhouse gas emissions increased 5.6% per year from 67.6 MtC in 1990 to 123.5 MtC in 2001. After 1990, emissions from industrial processes recorded a sharp increase of 10.2% per year.

Methane and nitrous oxide emitted from the agriculture and livestock sectors fell 0.8% per year between 1990 and 2001 due to the decline in land use for rice cultivation as well as a reduction in the use of fertilizer and in the number of livestock, among other factors. On the one hand, the amount of domestic sewage and industrial wastewater increased in line with the surging population and economic growth. However, stronger waste management policies since the mid-1990s have resulted in reducing emissions from the waste sector by an annual 4.2% over the same period.

Although progress in urbanization led to increased carbon dioxide emissions from soil due to land-use change, the total net removal from land-use change and forestry increased by 3.5% annually along with the steady increase of forest growth.

Total carbon dioxide emissions between 1990

〈Table 1-2〉 Greenhouse Gas Emissions & Removals Trend by Source

(Unit: 1,000 tC)

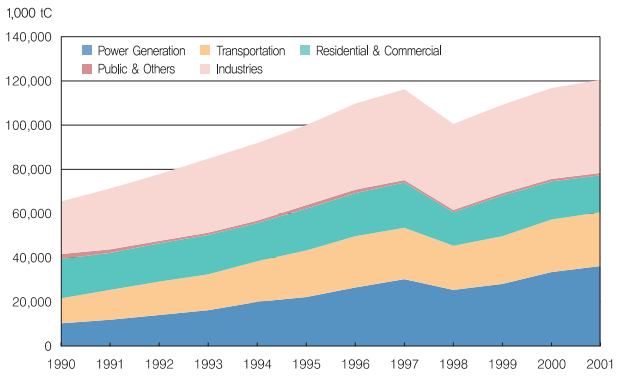
Classification	1990	1995	1998	1999	2000	2001	1990~2001 Average Annual Growth Rate (%)
Total Emissions	84,738 (100.0)	123,445 (100.0)	123,974 (100.0)	135,542 (100.0)	144,259 (100.0)	148,038 (100.0)	5.2
Energy	67,567 (79.7)	101,490 (82.2)	102,335 (82.5)	111,528 (82.3)	119,601 (82.9)	123,540 (83.5)	5.6
Industrial Processes	5,428 (6.4)	12,747 (10.3)	12,393 (10.0)	14,933 (11.0)	15,886 (11.0)	15,755 (10.6)	10.2
Agriculture & Livestock	4,798 (5.7)	4,917 (4.0)	4,821 (3.9)	4,656 (3.4)	4,519 (3.1)	4,405 (3.0)	−0.8
Land-Use Change & Forestry (Sinks)	−6,476	−5,793	−9,949	−10,422	−10,156	−9,448	3.5
Waste	6,945 (8.2)	4,291 (3.5)	4,425 (3.6)	4,425 (3.3)	4,254 (2.9)	4,337 (2.9)	−4.2
Net Emissions	78,262	117,651	114,025	125,120	134,102	138,590	5.3

Note: (−) sign denotes a sink.

〈Table 1-3〉 Promotional Strategies of Policies & Measures for GHG Reduction in Korea

Promotion of Technology to Reduce GHG & Development of Environment-Friendly Energy	• Designate GHG-reducing technology as one of the prospective environmental technologies to promote R&D. • Create a market demand for renewable energy by reinforcing the efforts to develop cleaner environment-friendly energy.
Strengthening of Policies and Measures for GHG Reduction	• Reinforce energy conservation efforts through integrally managed energy conservation policies and improve efficiency in energy usage. • Fortify energy conservation policies for the residential and commercial sectors by reinforcing energy efficiency standards for buildings & insulation level of building envelope and expanding the Energy Efficiency Labeling Program. • Conserve transportation fuel consumption by promoting cleaner alternative fuel and compact cars. • Reinforce GHG-reduction policy in the transport sector through efficient management of major transportation networks and traffic demand, establishment of a comprehensive logistics information network and standardization of logistics equipment. • Reinforce GHG-reduction policy by improving the methods of farming and animal husbandry in the agriculture and livestock sectors as well as promoting recycling and minimizing waste. • Conserve and expand forest sinks through afforestation and reforestation projects.
Inducement of Public Participation & Cooperation	• Promote PR and strengthen partnerships with industries and NGOs. • Motivate the public to participate and cooperate in the efforts to reduce GHG emissions by promoting PR and strengthening education programs for students and workers.

and 2001 rose by 5.8% per year.[1] Fuel combustion and industrial processes were the main sources of emissions. Most carbon dioxide emissions occur from fuel combustion which increased by 5.8% annually between 1990 and 2001 mainly attributable to power generation and the transportation sector. Emissions of methane fell 4.5% per year, which was attributed to the slowing energy sector along with the ordinarily high methane-producing waste and agriculture sectors. On the other hand, emissions of nitrous oxide recorded an annual increase of 6.0% over the same period.



[Figure 1-1] Trend of Carbon Dioxide Emissions from Fuel Combustion by Source

3. Policies & Measures

Recognizing that the conservation of energy and reduction of greenhouse gases not only contribute to international cooperation but are also consistent with the long-term development goals of the Korean economy, the various policies and measures related to energy conservation and reduction of greenhouse gas emissions as advocated by the UN Framework Convention on Climate Change (UNFCCC) have been established in Korea. In 2001, the agreement on the implementation plan for the Kyoto Protocol and changes in Korea's economic and industrial circumstances were reflected in the

1) The total carbon dioxide emissions do not reflect emissions and removals from land-use change and forestry sectors.

〈Table 1-4〉 Summary of Policies and Measures by Sector

Sector		Promotional Strategy	Policies and Measures
Energy	Demand	Integrally Managed Energy Conservation Policy	3-Year Plan for Energy Audit
			Expansion of Voluntary Agreement (VA)
			Energy Service Companies (ESCO)
		Improvements in Energy Efficiency	High Efficient Equipment Certification Program
			Energy Efficiency Standards & Labeling Program
	Supply	Expansion of Renewable & Clean Energy Use	Formation of Market Demand for Renewable Energy and Improvement in Its Economics
			Expansion of Integrated Energy Supply Project
			Stable Supply of Natural Gases
			Stable Supply Level of Nuclear Energy
			Promotion of Landfill Gas (LFG) Projects
	Building	Improvement of Energy Efficiency in Buildings	Mandatory Standards for Building Insulation & Energy-Efficient Designs
			Energy Efficiency Labeling Program for Buildings
			Green Building Certification Program
	Transportation Fuel	Promotion of Clean Fuel & Compact Cars	Promotion of CNG Buses and Compact Cars
			Development of Diesel Cars
Transportation		Efficient Management of National Transportation System & Traffic Demand	Promotion of Efficient Transport Mode Sharing
			Reduction of Traffic Congestion Areas
			Expansion of Public Transportation Service
			Traffic Demand Management
			Regulation on Idle Running Vehicles & Restriction on Car Use
		Establishment of Comprehensive Logistics Information Network & Standardization of Logistics Equipments	Establishment of Comprehensive Logistics Information Network
			Promotion of Logistics Standardization
Agriculture and Livestock		Improvements in Patterns of Farming and Animal Husbandry	Reduction of Methane from Irrigated Rice Paddies and Nitrous Oxide from Uplands
			Improvement in Enteric Management of Ruminant Livestock
			Improvement in Livestock Manure Treatment Facilities
Land-Use Change and Forestry		Forest Management	Promotion of Forest Tending Projects
			Control of Forest Pest Insects and Diseases
			Enforcement of Forest Fire Management System
		Forest Maintenance	Control of Deforestation and Replantation of Harvested Areas
		Afforestation	Promotion of Urban Greening
Waste		Minimization & Recycling of Waste	Waste Minimization
			Waste Recycling
		Establishment of Foundation for Waste Treatment	Municipal Waste Landfill Facilities
			Waste Incineration Facilities
			Sewage & Wastewater Treatment Facilities

Note: VA = Voluntary Agreement, ESCO = Energy Service Company, CNG=Compressed Natural Gas

establishment of the Second Comprehensive Action Plan (2002 ~ 2004). Through the Plan, efforts are being made nationwide to accelerate the steering of business activities to low energy-consuming industries and to conserve energy for the prevention of global warming.

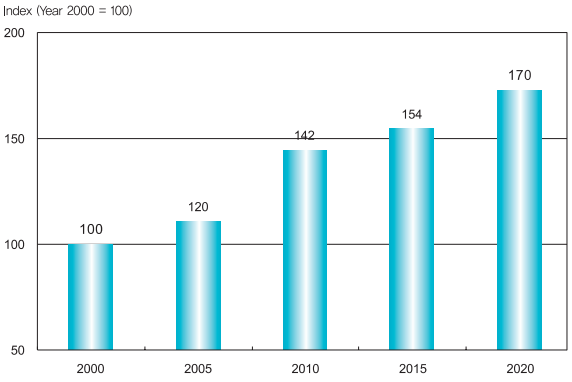
Accelerated development of advanced industries that are less energy-intensive such as the IT industry and other high-tech industries and active energy conservation efforts in all sectors will enable the early establishment of an economic structure that prioritizes energy conservation. This reflects Korea's basic policy direction and measures for greenhouse gas reduction in order to contribute to the global efforts to mitigate climate change. Korea's greenhouse gas reduction policies and measures by sector are summarized in (Table 1-4).

The reduction of greenhouse gases in the energy sector is being promoted by targeting energy supply and demand, heating and cooling of buildings, and transportation fuel. As regards energy demand, greenhouse gas reduction is being achieved through an integrally managed energy conservation policy and improvements in energy efficiency. For energy supply, policies are being devised to expand the use of renewable and cleaner energy. Futhermore, various policies and measures to improve energy efficiency in buildings, expand the use of clean fuel, and broaden the market demand for compact cars are also being formulated.

In the transportation sector, various greenhouse gas reducing efforts are being made through two promotional goals: (1) efficient management of the national transportation system and traffic demand and (2) establishment of a comprehensive logistics information network and standardization of the logistics apparatus. Greenhouse gas reduction efforts are also being made in the agriculture & livestock sectors by improving farming and animal husbandry methods. As for the waste sector, policies and measures to establish a foundation to minimize waste, increase recycling and expand waste management processes are being implemented. Policies to increase removals and decrease emissions are also being implemented in the forestry sector through efficient management and maintenance of forests and afforestation.

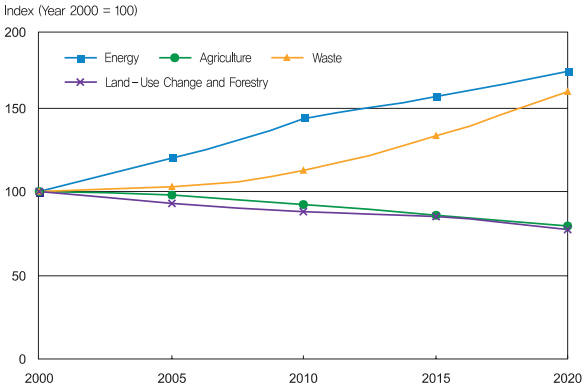
4. Projections of Greenhouse Gas Emissions

The growing trend of greenhouse gas emissions will continue if the current shift of Korea's industrial structure continue and considerable efforts to reduce emissions are not implemented. Projections indicate that Korea's greenhouse gas emissions[2] will rise by 70% above 2000 levels by 2020 (Figure 1-2). However, the carbon dioxide intensity during the forecast period is expected to gradually decrease due to improvements in demand-side energy efficiency and shifts to cleaner fuels.

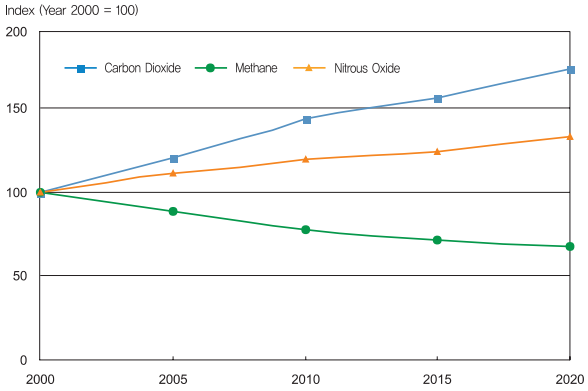


[Figure 1-2] Projected GHG Emissions Trend (2000~2020)

2) Emissions from the fugitive sources, industrial processes and alternatives for CFCs (HFCs, PFCs, SF_6) have been excluded from the projection.



[Figure 1-3] Projected GHG Emissions and Removal by Source/Sink (2000~2020)



[Figure 1-4] Projected Emissions by Gas (2000~2020)

Greenhouse gas emissions from energy, agriculture and waste which accounted for about 90% of the total emissions of greenhouse gases is expected to increase by 2.7% annually from 2000 to 2020. During the same period, emissions from fuel combustion will increase by 2.8% annually and emissions from waste by 2.4%, whereas removals from sinks and emissions from agriculture are projected to annually decrease by 1.4% and 1.1%, respectively.

Carbon dioxide, the main gas among energy related GHG, will see a relatively modest increase of 2.9% annually from 2000 and 2020 and account for 96.8% of all greenhouse gas emissions[3] in 2020 from the 93.5% in 2000. This is largely due to the government's energy conservation efforts to comply with the UNFCCC as well as improvements in energy efficiency, increase in the consumption of low carbon energy and renewable energy and increase in waste incineration.

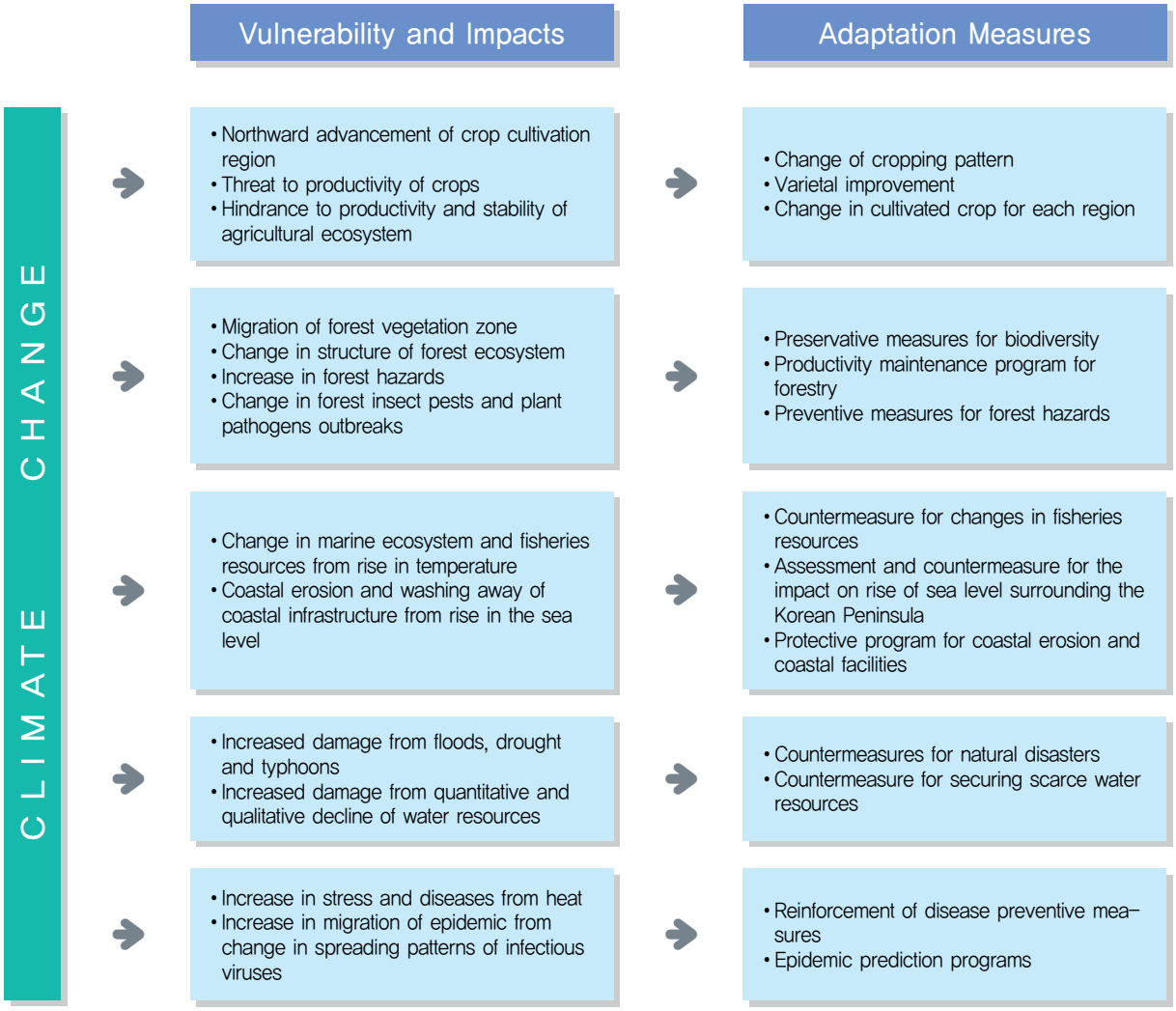
Although emissions of nitrous oxide and methane from waste are expected to increase, projections indicate emissions of nitrous oxide, which accounted for 1.8% of total greenhouse gas emissions in 2000, will decrease by 1.2% annually and account for 1.4% in 2020. Methane emissions are also expected to decrease by 1.9% annually from occupying 4.6% of total greenhouse gas emissions in 2000 to 1.8% in 2020 due to the reduction in the number of livestock and land dedicated to rice cultivation.

5. Vulnerability Assessment, Climate Change Impacts and Adaption Measures

Climate change is projected to seriously impact agriculture, forestry & fisheries, the coastal and marine environment, terrestrial ecosystem, natural disasters, health, etc. Korea has continually conducted active research regarding the impact assessment of climate change on various socio-economic and natural systems, and the development of adaptation measures to mitigate adverse impacts of climate change.

In the agriculture sector, the culturable period and the culturable region of crops will be expanded, ascending northward while the productivity and stability of existing cultivation sites for each

3) Emissions from the fugitive sources, industrial processes and alternatives for CFCs (HFCs, PFCs, SF_6) have been excluded from the projection.

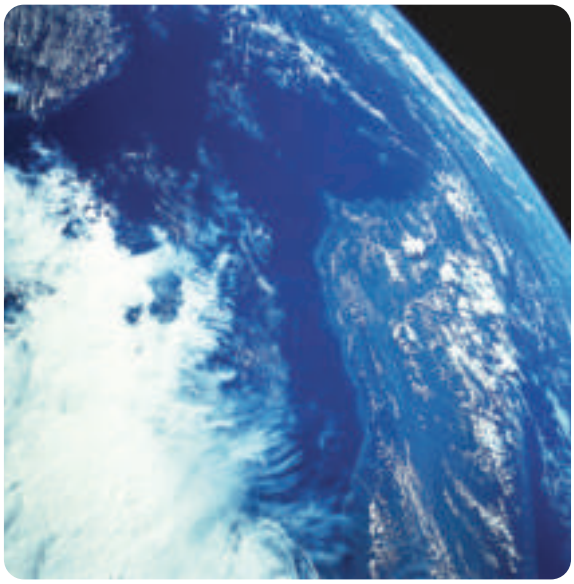


[Figure 1-5] Vulnerability, Impacts and Adaptation Measures for Climate Change in Korea

crop will be greatly threatened. For the forestry sector, as the climate changes, temperature will rise and rainfall will increase, causing CO_2 concentration in the atmosphere to increase and the length of the growing season to lengthen. This may result in an increase of forest productivity. But on the other hand, other limiting factors such as forest fires, landslides, outbreak of insects, pests and plant pathogens may occur as negative impacts. Forests composed of such tree species as the *Pinus koraiensis* which are acclimated to colder environment may decline due to the physiological stress caused by the warmer environment.

Furthermore, climate change will result in the rise of the water temperature and sea level in the surrounding waters of the Korean Peninsula, which will ultimately cause changes in the ocean circulation pattern and sea water characteristics, resulting in the change of the marine ecosystem impacting the distribution of fisheries resources. In addition, the rise in water temperature from climate change may induce long-term and large-scale red tide, which would seriously damage the production of fish and shellfish.

The scale and frequency of floods are expected



to increase from climate change. Droughts in Korea are caused by massive fluctuations in outflow for each year and season, hence, even the average increase in rainwater will not contribute to the relief of water shortage if the range of change in water fluctuation in outflow increases, but will rather worsen the shortage. Furthermore, global warming is expected to cause a rise in the sea level and shifts in the pattern of typhoons and rainfalls which will greatly disrupt the socio-economic activities of the coastal zone.

Global warming also affects the natural ecosystem. The tendency of bud bursting period for tree leaves and blooming period for flowers have been observed to occur earlier due to the warmer winters. It is predicted that major outbreaks of problematic pest insects in the southern region will ascend northward and expand to the central regions. Furthermore, as the temperature rises, the possibility of weeds developing an advantage over crops will increase, functioning as an element that will greatly impact agricultural productivity.

Furthermore, it is expected that the distribution ranges of plants will migrate northward in latitude and upward in altitude according to the warmer environment. Furthermore, in all coastal regions of the Korean Peninsula, the rise in the sea level is predicted to most seriously impact the tidal flats which are crucial ecosystems for pollution purification and biological productivity.

The Korean government has determined that adaptation measures are necessary to cope with the anticipated climate change in the agriculture, forestry, fisheries, water resources, coastal zones, natural ecosystems and health sectors at large. In the forestry sector, for instance, multilateral adaptation strategy is necessary for the sustainable conservation of biological diversity and for the maintenance of forest productivity to counterbalance the anticipated rapid climate change.

As regards the ocean, long-term monitoring of the change in the marine ecosystem is necessary to predict the shift in fisheries resources resulting from climate change and variations of fishing grounds, and to continuously utilize and manage fisheries resources. Fundamental research is being conducted with the recognition that a long-term adaptation program should be established for coastal infrastructure and territorial safety supervision to confront climate change that would cause a rise in the sea level, changes in the path and intensity of cyclones, changes of wave influence, etc.

In the water resources sector, efforts are being made to establish a systematic and efficient structure that will communicate early warnings to the central government and local authorities to enhance the efficiency of water resource management and minimize damage from disasters. In the health sector, responsible government ministries and bureaus are implementing forecasting projects on the prevalence of diseases using accumulated data. Studies on the severity of the impact of climate

change on human health is constantly assessed.

6. Financial Resources and Technology Transfer

Korea not only actively participates in greenhouse gas reduction activities of the UN Framework Convention on Climate Change (UNFCCC) but also contributes financial assistance, technologies and resources to support the activities of environment-related international institutions and programs such as the UN Environment Programme (UNEP) and the World Meteorological Organization (WMO). Korea is an active supporter of the international community's efforts to preserve the global environment. In May 1994, it became a member of the Global Environment Facility (GEF), which was established for the purpose of supporting global environment protection activities among developing countries. As the Korean economy takes on a more significant role in the world economy, its level of contribution continues to grow.

The cooperative development programs for developing countries operated by the Korean government consist of grants and loans. In the past, such cooperative development programs focused on promoting trade and investments, fulfilling basic human needs and developing human resources. Nowadays, the focus is directed at promoting sustainable development, strengthening partnerships with developing countries and instilling in them a higher sense of the responsibilities of ownership towards development projects. Furthermore, the environment, eradication of poverty, women's empowerment and deterring overpopulation have emerged as major issues for cooperative development.

As a member of the Organization for the Economic Cooperation and Development (OECD) and

an advanced developing country, Korea also actively participates in international efforts toward the prevention of global warming and has examined various potential projects in which to participate. Current projects in progress include the "KOICA Training Program on Energy Conservation & Utilization Efficiency" led by Korea, the "Climate Technology Partnership - Korea" led by the United States and various projects which are being pursued through the International Energy Agency (IEA) and the Asia-Pacific Economic Cooperation (APEC) as well as a wide range of bilateral cooperation programs.

7. Research and Systematic Observation

Korea has been reinforcing its capabilities to tackle a variety of issues on climate change. Epochal improvements in technology have been made through diverse research and technological developments to derive and analyze direct and indirect impact of climatic change. Furthermore, dramatic results have been achieved in the research and technology sectors in the effort to approach the level of developed nations.

Research and technology development projects cover all areas of society including energy, transportation, agriculture and livestock, forestry, the ocean, atmosphere and natural ecosystem at large. Government departments and agencies have established and promoted comprehensive mid- to long-term plans to foster research corresponding to each particular field under scrutiny and to study the distinctive qualities of the relevant responsibilities thereof. Such research and development projects aimed at meeting the objectives of UNFCCC have been implemented not only by the central government, but also by the local authorities. Furthermore, the Korean government has chosen research & technology development tasks as a core national project and continually provides research funds to the relevant entities.

In the energy sector, research and technological development projects have been selected in the areas of renewable energy, energy conservation, carbon dioxide emissions reduction and carbon dioxide sequestration at large for concentrated promotion to increase the supply of renewable energy, achieve energy conservation, reduce carbon dioxide and expand its sequestration. As for industrial processes, technological development and equipment replacement projects are being promoted to reduce PFC emissions by the semiconductor industry.

In the area of transportation, research and technological development on sustainable traffic system, countermeasures for reducing greenhouse gas emissions by local authorities, appraisal of traffic/environment costs, characteristics of vehicle emissions and measurement of emission levels are being promoted.

In the agriculture and livestock sectors, research and technological development projects are concentrated on countermeasures to methane and nitrous oxide emissions. Especially, research and technology development on reduction of methane and nitrous oxide from rice paddies and uplands and methane from manure decomposition have been vigorously promoted. In the forestry sector, research has been carried out on biomass and greenhouse gas inventory system, soil carbon contents, forest biodiversity and forest ecosystem change due to global warming, etc. As regards the ocean, research is being conducted on such issues as the impact of global warming, adaptation strategies and development of technologies relevant to the marine ecosystem.

Research and technology developments have also been promoted to predict and monitor climate change and the environmental impact. For atmospheric monitoring, research has been carried out with a focus on monitoring GHG concentration on the Korean Peninsula and development of climate change measurement technologies. Furthermore, research on the assessment of the socio-economic environmental impacts of climate change, the cor-

relation between climate change and human health and the development of policy measures have also been implemented. In addition, the integrated climate change impact model has been developed to formulate sectoral and regional adaptation strategies.

Observations relevant to climate change have been actively implemented with major focus on the atmosphere, ocean and forestry. Furthermore, to efficiently implement the observation activities, collaborative systems with international organizations and groups have also been established for each sector.

8. Education, Training and Public Awareness

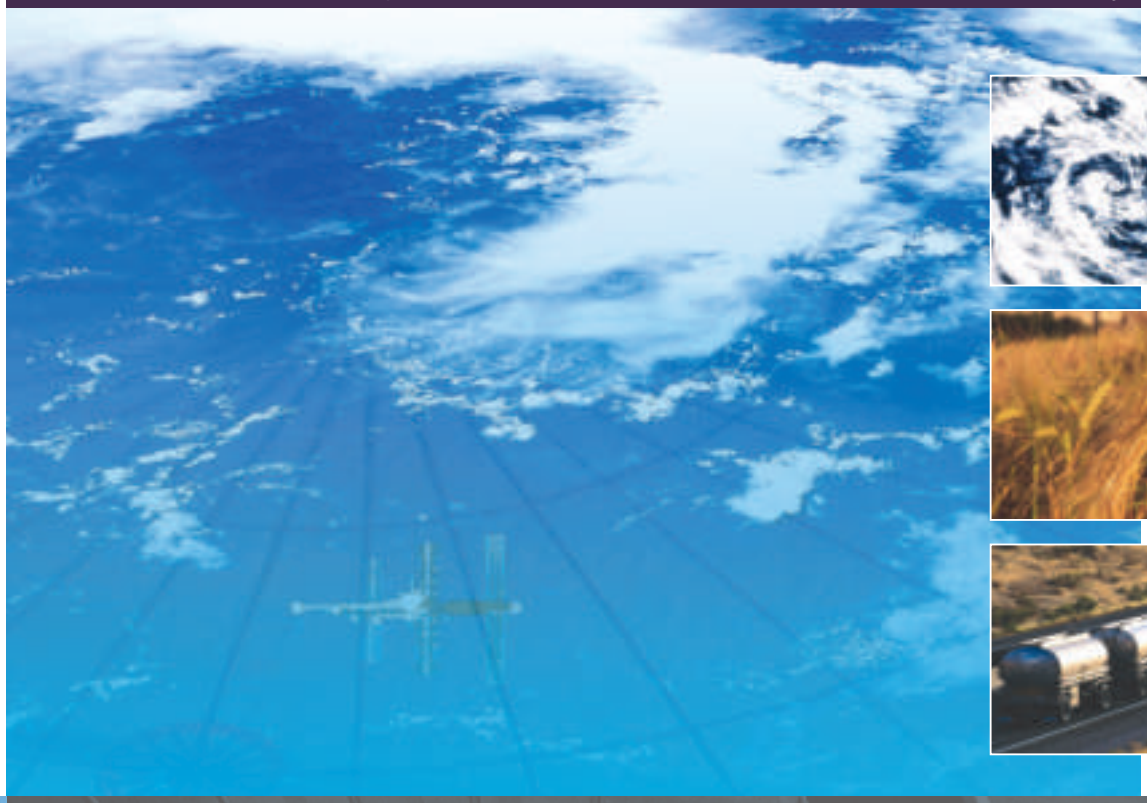
Korea is striving to better inform and educate the public about global warming and the UN Framework Convention on Climate Change (UNFCCC) to achieve a national consensus on Korea's commitment towards the international efforts to create an environment that encourages industries and individuals to voluntarily take part in the efforts. As such, systematic educational programs are targeted accordingly by source, means and stage.

First of all, positive values are established on environmental issues by educating the public about the adverse effects of climate change and its preventive measures. This not only encourages energy-saving and environment-preserving habits but also provides a lasting fundamental resolution to the reduction of greenhouse gas emissions. Systematic environment and energy programs reflecting UNFCCC guidelines and energy conservation at large are being instituted in the regular curriculum of primary and secondary schools. Environment-related education programs are also being provided during discretionary activity hours in schools. Furthermore, the Korean government has assigned and is funding various model schools for energy conservation and environment preservation. Other efforts by the government include the publication and distribution of textbooks to be used in environmental education programs and continuous training of teachers. In addition, selected graduate schools have been designated for UNFCCC specialization in which research will be focused on policy measures, international negotiation, UNFCCC specialists in corporations, statistical analysis, etc.

The government is working to enhance public awareness and forge a national consensus on the seriousness of global warming and is forming partnerships with industries and NGOs to enhance the effectiveness of the measures for mitigating climate change. Moreover, the adverse effects of global warming is being publicized throughout the country to motivate the people to participate in the reduction of greenhouse gases. Three different scenarios targeting three specific groups - opinion leaders, people working in industries and the general

public - have been implemented for more effective public relations.

To exploit the rising public awareness of climate change, various NGOs are spearheading active citizen movements and public enlightenment campaigns through research, PR activities and education. Besides being observers of environment protection, their range of activities has expanded to include the planning and implementation of policies. Through their close connection with NGOs abroad, they actively contribute to the cause of tackling worldwide environmental issues.



Chapter 2 National Circumstances

Chapter 2

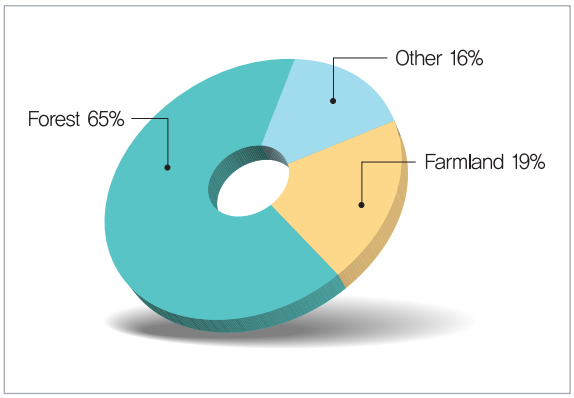
National Circumstances

1. Geographic Setting

Korea comprises the southern region of the Korean Peninsula in Far East Asia. It shares the Yellow Sea with China to the west and the East Sea and the Korean Straits with Japan to the east and the south, respectively.

Korea lies between 125° 04′ and 131° 52′ east longitudes and between 36° 06′ and 38° 27′ north latitudes. As of 2001, the land covered an area of 99,954 km^2 approximately 550 km long and 300 km width with over 3,200 islands scattered off the mainland.

The configuration of the land surface is higher



Source: Ministry of Government Administration and Home Affairs

[Figure 2-1] Proportion of Land Usage in Korea

in the east and lower in the west. Mountainous regions rising more than 1,000 m above sea level are clustered towards the north and east forming a ridge along the terrain which declines steeply towards the East Sea and descends slowly westward towards the Yellow Sea. As regards the terrain, 65% of the land consists of forests and 19% is used as farmland (Figure 2-1). Korea has a relatively high variability of precipitation, which ranges from high in summertime to low in wintertime. This poses some disadvantages in generating hydro power and maintaining various water resources. The river flow is controlled by dams in upstream and midstream parts of rivers that have created numerous man-made lakes and reservoirs.

2. Climate

Situated in the temperate mid-latitude zone, Korea is endowed with four distinct seasons. Winters are cold and dry from the influence of the cold, dry continental air mass and summers are generally hot and humid because it lies on the edge of the constant North Pacific anticyclone system. During spring and autumn, the migratory anticyclones provide relatively clear skies but also cause substantial fluctuations in the weather and climate.

With the exception of mountainous areas in the central region, the annual average temperature is about 10 ~ 16℃ based on climate records between 1971 and 2000: 23 ~ 27℃ in August, the hottest month of the year; 16 ~ 19℃ in May; 11 ~ 19℃ in October and -6 ~ 7℃ in January, the coldest month of the year. The average annual precipitation between 1971 and 2000 recorded 1,100 ~ 1,400 mm in the central region, 1,000 ~ 1,800 mm in the southern region and 1,450 ~ 1,850 mm on Jeju Island. Most of the rainfall, 50 ~ 60%, occurs in the summertime. [Figure 2-2] ~ [Figure 2-5] indicate the average annual temperature and precipitation between 1971 to 2000 as well as seasonal averages.

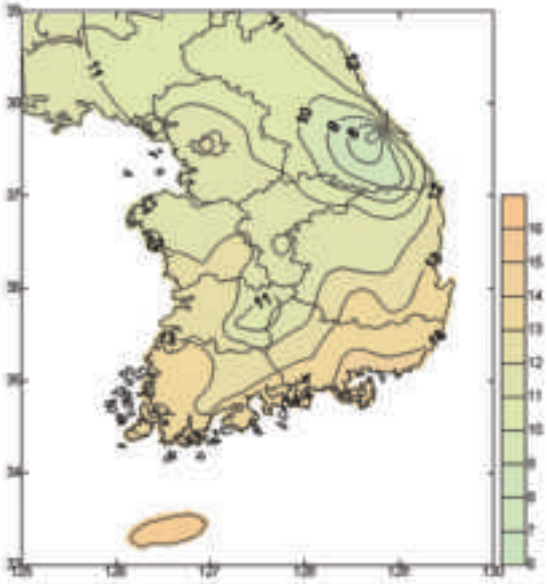
Each season is characterized by contrasting wind systems. The direction of the winds changes from strong northwesterly winds in the winter to southwesterly winds in the summer. The nation's humidity level reaches its peak in July at 80% and drops to around 60% during the cold months. The rainy season associated with the East Asia monsoon, or "*CHANGMA*" in Korean, starts during late June and lasts for about one month on average. Approximately 27 typhoons develop in the western region of the North Pacific Ocean every year,

〈Table 2-1〉 Heating and Cooling Degree Day (Seoul)

(Unit: Degree-days)

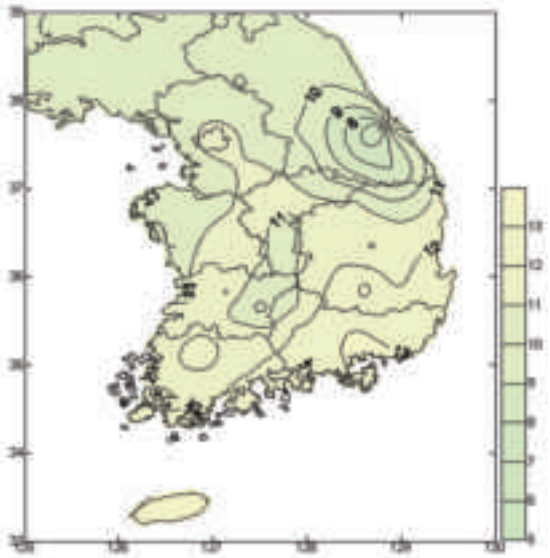
Year	Mean Temperature (℃)	Heating Degree-Day	Cooling Degree-Day
1990	12.8	2,558	674
1995	12.2	2,739	646
2000	12.7	2,759	824
2001	12.8	2,721	844

Sources: Ministry of Commerce, Industry and Energy & Korea Energy Economics Institute, *Yearbook of Energy Statistics*, Various Volumes



Source: Korea Meteorological Administration

[Figure 2-2] Average Annual Temperature (℃), 1971~2000



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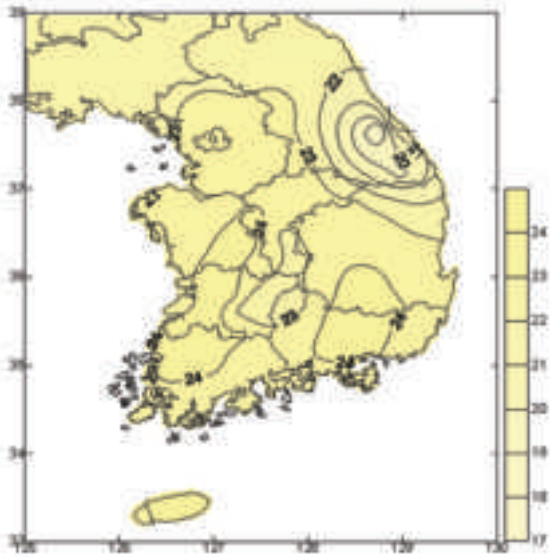

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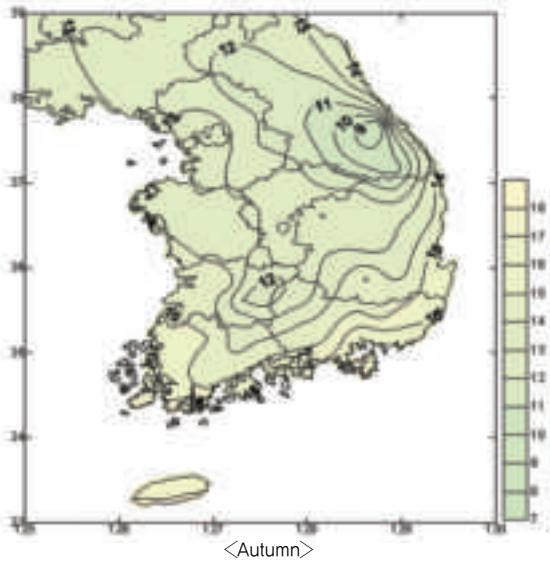

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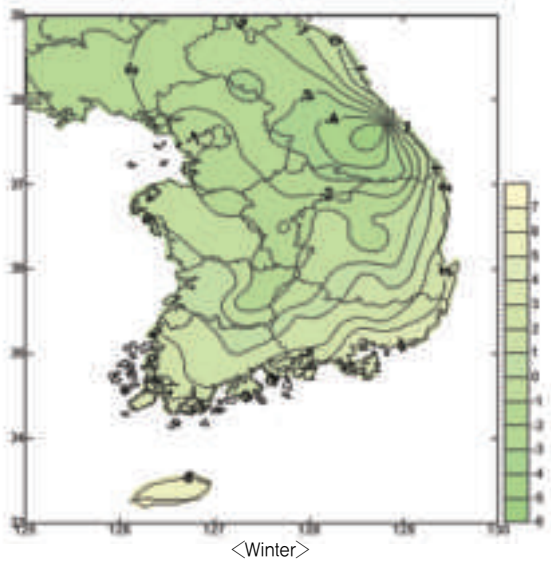

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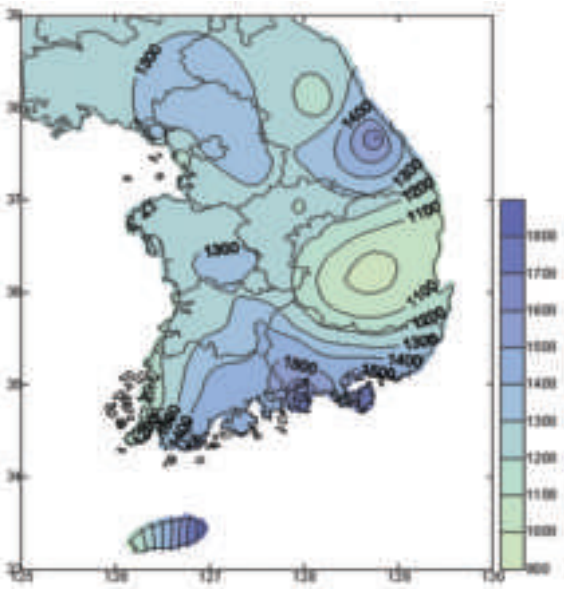
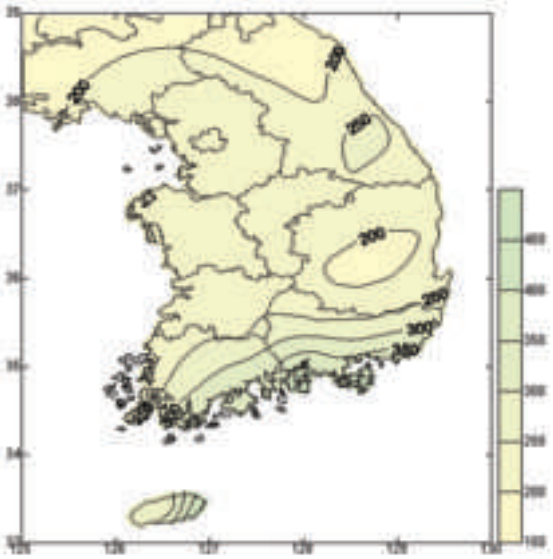
Source: Korea Meteorological Administration

[Figure 2-3] Average Annual Temperature (℃) by Seasons, 1971~2000



Source: Korea Meteorological Administration

[Figure 2-4] Average Annual Precipitation (mm), 1971~2000



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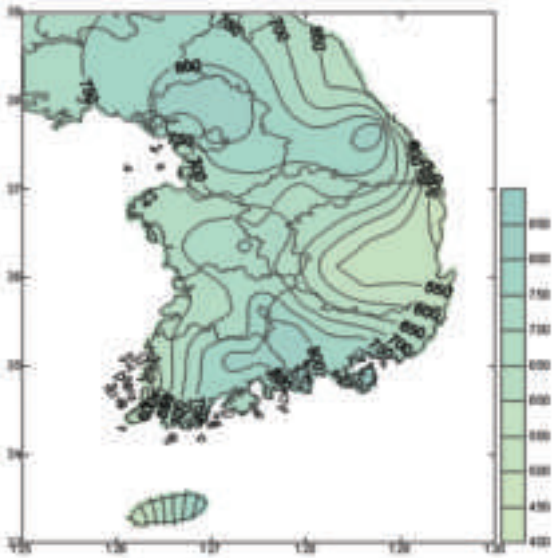

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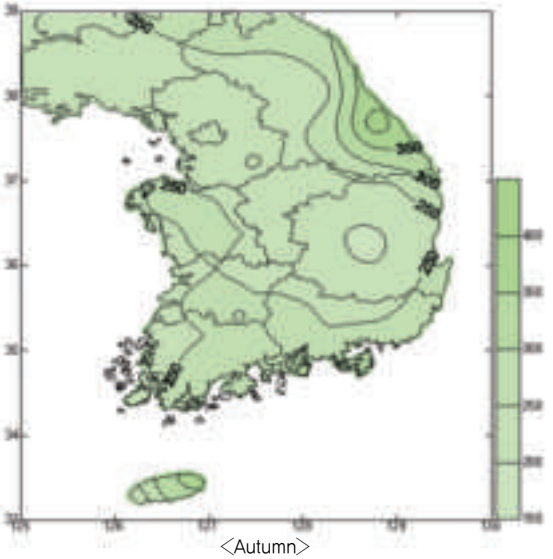

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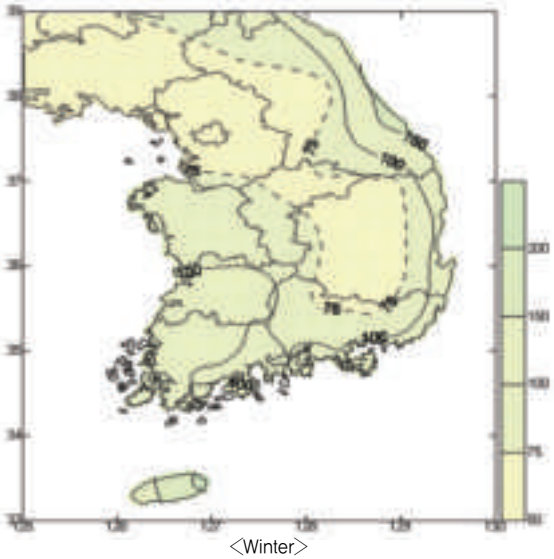


<Winter>

Source: Korea Meteorological Administration

[Figure 2-5] Average Annual Precipitation (mm) by Seasons, 1971~2000

among which 2 ~ 3 directly and indirectly influence Korea .

An analysis of the heating and cooling degree days-a major indicator influencing energy consumption-shows the heating degree days at 2,500 ~ 3,000 to be four times greater than the 700 ~ 800 cooling degree days in Korea (Table 2-1). indicates the heating/cooling degree days in Seoul.

3. Population

At the end of 2001, Korea's population stood at 47.343 million with an annual growth rate of 0.91% between 1991 and 2001 and a sex ratio of 101.4 males per 100 females, or 23.835 million men and 23.508 million women. Korea accounts for about 0.8% of the world's total population of 6.057 billion which ranks the nation as the 25th largest in terms of population. With the exception of various city-states and small countries, Korea's population density of 474 persons per square kilometer makes it the world's third most densely populated country after Bangladesh and Taiwan.

The 3% population growth rate of the 1960s declined sharply to 2% in the 1970s due to improved social and financial living standards, changed social perspective on population issues, and campaigns to control the growing population. The rate has dropped further to below 1% since 1985. If this trend continues, Korea's population is projected to grow to 48.461 million by 2005 and 50.650 million by 2020.

〈Table 2-2〉 Population and Average Density

Year	Population (1,000)	Population Growth Rate(%)	Population Density (Person/km^2)
1990	42,869	0.99	431.8
1995	45,093	1.01	454.3
2000	47,008	0.84	472.6
2001	47,343	0.71	473.6

Source: National Statistical Office

In 2000, the population in the age group of 30 ~ 34 recorded the highest number at 4.316 million (9.12%), followed by 35 ~ 39 at 4.224 million (8.92%) and 25 ~ 29 at 4.215 million (8.90%). The population aged 65 years and over accounted for 7.9%. Korea's senior population ratio stood at 7.1% in 2000, thus making Korea an emerging aging society according to UN standards which define a society with the senior population over 7% as an aging society and over 14% as an aged society.

4. Government Structure

The Republic of Korea is a democratic republic with a presidential system. The President is elected by direct popular vote for a single five-year term. The Executive Branch is headed by the President and is held in check by the Legislative Branch steered by the members of the National Assembly.

The government consists of 18 ministries, 4 agencies and 16 bureaus of which the ministries and offices including the Office for Government Policy Coordination, the Ministry of Commerce, Industry and Energy, the Ministry of Environment, the Ministry of Foreign Affairs and Trade, the Ministry of Agriculture and Forestry, and the Ministry of Science and Technology systematically collaborate in handling issues concerning the UN Framework Convention on Climate Change.

The local autonomous system was launched in Korea with the members of the Local Councils being directly elected by the people in 1991. The nation fully embraced local autonomy in 1995 when local governors and mayors were also elected

by direct elections. In the ten years since the institution of the local autonomous system, the current local governments have established their own resources and manage their administrative affairs independently from the central government.

5. Economy

Korea has taken aggressive measures for economic development since the 1970s which prompted high year-on-year economic growth rate, attaining an average annual growth rate of 8.8% between 1986 and 1995. Rapid growth in trade has established Korea as the world's 11th largest economy. Korea's leading industries include shipbuilding, semiconductors, electronics and auto manufacturing.

Since 1945, the industrial structure focused on labor-intensive light industries, especially the textile industry, which led Korea's economic growth. The economic development plans, which began in the 1960s and ended in the late 1990s, prompted the expansion of key industries, infrastructure and other industry-supporting facilities and the establishment of export-oriented strategies. The service industry as well as the mining and manufacturing industries greatly expanded by 2001 resulting in the mining and manufacturing industries accounting for 39.2% and service industries 46.8%, whereas agriculture, forestry and fisheries accounted for 5.6% (Table 2-3).

Among manufacturing industries, the proportion of energy-intensive oil, chemical, ceramic and primary metal industries shows a declining trend while that of technology-intensive industries such as metal and machinery is on the rise. Furthermore, Korea's steel, shipbuilding, auto manufacturing and electronics industries are highly competitive in the world market and cement, plywood, chemical fertilizers, footwear, clothing and ceramics are major export items. According to the 2001 figures, the United States emerged as Korea's largest export market accounting for about 20% of total exports followed by China (12%), Japan (11%), Hong Kong (6%), Taiwan, Germany and Singapore. On the other hand, Japan was Korea's biggest importer occupying 19% of total imports followed by the United States (16%), China (9%), Saudi Arabia and Australia.

Korea's GDP rose 1.7 fold from 252.5 billion dollars in 1990 to 427.3 billion dollars in 2001 and its per capita GDP rose 1.5 fold accordingly from 5,890 dollars in 1990 to 9,025 dollars in 2001 (Table 2-4).

〈Table 2-3〉 Korea's Industrial Structure

(Unit: %)

Year	Agriculture, Forestry & Fisheries	Mining & Manufacturing			Construction	Services
		Mining	Manufacturing	Utilities		
1980	15.7	1.7	27.5	1.2	12.1	41.8
1985	14.0	1.1	29.2	1.7	11.6	42.4
1990	8.7	0.7	31.8	2.1	12.9	43.8
1995	6.8	0.5	32.2	2.3	12.4	45.8
2000	5.7	0.3	36.7	2.8	8.3	46.1
2001	5.6	0.3	36.0	2.8	8.5	46.8

Source: National Statistical Office

〈Table 2-4〉 Korea's Gross Domestic Product (GDP) & Per Capita GDP

Year	GDP ($billion)	GDP Per Capita ($)
1985	93.4	2,289
1990	252.5	5,890
1995	489.4	10,853
2000	461.7	9,766
2001	427.3	9,025

Source: The Bank of Korea

Despite Korea's positive economic growth since the 1970s, its current account deficit continued to accrue until the start of the 1990s as high wages, increase in the price of raw materials and other elements hiking the price of exports aggravated Korea's trade balance and the surge in overseas travel further deepened the deficit in the current account balance. However, difficulties arising from the 1997 financial crisis which precipitated a bailout loan from the International Monetary Fund (IMF), forced Korea's economy to adopt improvements in irrational systems, corporate restructuring and removal of inefficiencies in industries. Such measures have prompted a continuing current account balance surplus since 1998.

During the past several years, extensive restructuring in the corporate sector has shut down ailing companies, enhanced management transparency in those that survived, eliminated cross-payment guarantees among subsidiaries and instilled an overall system of sound financial practices. Furthermore, large corporations were induced to focus on core competencies to sharpen their international competitiveness. The successful restructuring of the corporate sector has been noticed by the international community and helped Korea recover its sovereign credit rating which was downgraded after the bailout loan from the IMF. Although painful, the restructuring process has been successful and significant foreign investments are now flowing into Korea.

6. Agriculture

Agricultural land has continued to diminish by an average annual of 22,000 hectares during the past decade due to rapid urbanization and increasing allotment of fallow land to the construction of buildings, public facilities, etc. Total agricultural land, according to 2001 estimation, stood at 1,876,000 hectares, of which 61.1%, or 1,146,000 hectares, was rice paddies and the remaining 38.9%, or 730,000 hectares, was uplands (Table 2-5). The utilization rate of agricultural land has remained at 110% without any significant change in the past 5 years.

〈Table 2-5〉 Agricultural Land Use

(Unit: 1,000 ha (%))

Year	Total	Rice Paddies	Uplands
1980	2,196 (100)	1,307 (59.5)	889 (40.5)
1990	2,109 (100)	1,345 (63.8)	763 (36.2)
1995	1,985 (100)	1,205 (60.7)	779 (39.3)
2000	1,889 (100)	1,149 (60.8)	740 (39.2)
2001	1,876 (100)	1,146 (61.1)	730 (38.9)

Sources: Ministry of Government Administration & Home Affairs, National Agricultural Products Quality Management Service
Note: The areas of rice paddies and uplands refer to land category.

〈Table 2-6〉 Fertilizer Consumption

(Unit: 1,000 tons)

Year	Total	Nitrogenous	Phosphorous	Potassic
1980	828	448	196	184
1990	1,104	562	256	286
1995	954	472	223	259
2000	801	423	171	207
2001	717	375	153	189

Source: Ministry of Agriculture & Forestry, *Yearbook of Agricultural & Forestry Statistics*, Various Volumes

〈Table 2-7〉 Number of Livestock

(Unit: 1,000 heads)

Classification		1980	1990	1995	2000	2001
Ruminant	Beef Cattle	1,361	1,622	2,594	1,590	1,406
	Dairy Cattle	180	504	553	544	548
Others	Poultry	40,130	74,463	85,799	102,547	102,393
	Swine	1,784	4,528	6,461	8,214	8,720
Total		43,455	81,117	95,407	112,895	113,067

Source: Ministry of Agriculture & Forestry, *Yearbook of Agricultural & Forestry Statistics*, Various Volumes

Korea has been endeavoring to improve the living standards of farming and fishing communities and agriculture-related systems since the 1980s and has made efforts towards the creation of an efficient structure for the distribution of agricultural goods. As part of such efforts, educational institutions and social service facilities have been expanded and housing and infrastructure in rural communities have been repaired where needed and modernized.

Fertilizer consumption is directly related to the total area under cultivation, and a reduction in farmland will gradually lessen the overall consumption of fertilizer (Table 2-6). Nitrogenous fertilizer, which emits nitrous oxide, accounts for about 50% of the total fertilizer consumption.

Livestock production results in the emission of the greenhouse gas, methane (CH_4), which is produced by enteric fermentation of livestock. As more and more meat is consumed by the changing diet of Koreans, the number of livestock increased from 95,407 heads in 1995 to 113,067 heads in 2001. The number will continue to increase along with the increase in meat consumption for a significant amount of time.

7. Forestry

Korean forests are of the cool-temperate and warm-temperate varieties. The warm-temperate zone is south of the 35° north latitude where the annual mean temperature is over 14° C. This includes part of the southern coastal regions and the islands off the coast as well as Jeju island. The area is characterized by dense broad-leaved evergreen forests consisting of *Quercus acuta, Camellia japonica, Cinnamomum camphora,* etc. The cool-tem-

〈Table 2-8〉 Forest Land Area & Growing Stock

Year	Area (1,000 ha)*	Growing Stock (1,000m³)	Growing Stock Per Hectare (m³)
1970	6,611	66,750	10.07
1980	6,568	145,694	22.18
1990	6,476	248,426	38.36
2000	6,422	407,575	63.47
2001	6,415	428,346	66.77

Source: Korea Forest Service, *Yearbook of Forestry Statistics*, Various Volumes
* includes unstocked forest land.

〈Table 2-9〉 Forest Area by Forest Type

(Unit: 1,000 ha)

Year	Total	Coniferous	Broad-leaved	Mixed	Bamboo
1970	5,700 (100)	3,268 (57.3)	1,207 (21.2)	1,219 (21.4)	6 (0.1)
1980	6,301 (100)	3,249 (51.6)	1,148 (18.2)	1,899 (30.1)	5 (0.1)
1990	6,286 (100)	3,079 (49.0)	1,389 (22.1)	1,810 (28.8)	8 (0.1)
2000	6,268 (100)	2,711 (43.2)	1,666 (26.6)	1,885 (30.1)	6 (0.1)
2001	6,266 (100)	2,692 (43.0)	1,672 (26.7)	1,896 (30.2)	6 (0.1)

Source: Korea Forest Service, *Yearbook of Forestry Statistics*, Various Volumes

perate zone is in the 35~45° north latitude where the annual mean temperature is 6~14℃. Most of Korea lies in the cool-temperate zone where the forests are dominated by broad-leaved deciduous species such as *Quercus* spp., *Acer* spp., *Fraxinus* spp. and coniferous trees such as *Pinus densiflora* and *Pinus koraiensis*.

Although 65% of the total land area in Korea is covered by forests, 87% of the trees are less than 30 years old and have not yet reached full maturity. Most of the timber in the Korean market is imported and the domestic supply rate stands at a mere 13%.

About half of the forest lands consists of coniferous forests and the remainder consists of broad-leaved forests and mixed forests. However, the area of coniferous forests is diminishing while that of broad-leaved forests is increasing due to natural succession.

8. Energy

Korea's primary energy consumption was estimated at 192.9 million TOE (tons of oil equivalent) in 2000 and its energy consumption ranks as the 10th largest in the world. Since Korea is the world's 13th largest economy, its economic rank is similar to its rank in energy consumption. Of the total energy consumed, 97.2% is imported with a total expenditure of 37.6 billion dollars. The increasing trend of energy consumption saw a decline of 8.1% in 1998 from the effects of the foreign exchange crisis. However, it regained a world record high of 9.3% in 1999 and recorded an increase of

〈Table 2-10〉 Primary Energy Consumption by Source

(Unit: 1,000 TOE)

Year	Coal	Oil	LNG	Hydraulic	Nuclear	Others*	Total
1980	13,199	26,830	–	496	869	2,517	43,911
1985	22,022	27,142	–	915	4,186	2,031	56,296
1990	24,385	50,175	3,023	1,590	13,222	797	93,192
1995	28,091	93,955	9,213	1,369	16,757	1,051	150,437
2000	42,911	100,279	18,924	1,402	27,241	2,130	192,887
2001	45,711	100,385	20,787	1,038	28,033	2,456	198,409

Sources: Ministry of Commerce, Industry and Energy & Korea Energy Economics Institute, *Yearbook of Energy Statistics*, Various Volumes
Note: Resources since 1997 are based on a new system of categorizing petroleum types which includes raw naphtha.
* New renewable energy sources included since 1992.

〈Table 2-11〉 Final Energy Consumption by Sector

(Unit: 1,000 TOE)

Year	Industrial Processes	Transport	Residential & Commercial	Public & Others	Total
1980	16,571	4,905	14,034	2,087	37,597
1985	20,014	6,707	18,180	2,096	46,998
1990	36,150	14,173	21,971	2,812	75,107
1995	62,946	27,148	29,451	2,416	121,962
2000	83,912	30,945	32,370	2,625	149,852
2001	85,158	31,909	32,893	2,989	152,950

Source: Ministry of Commerce, Industry and Energy & Korea Energy Economics Institute, *Yearbook of Energy Statistics*, Various Volumes

6.4% in 2000. It became the world's 6th largest oil consuming nation, 3rd largest importer of oil and 2nd largest importer of coal and natural gas in 2000.

In 2001, the consumption of primary energy was estimated at 198.4 million TOE, recording an increase of about 2.9% from the previous year, which translates into an expenditure of 33.7 billion dollars on imported energy. Energy production by source in 2001 revealed oil to be the highest at 50.7% followed by coal (23.0%), nuclear energy (14.1%), LNG (10.5%), hydraulic power (0.5%) and others (1.2%). Of the total energy consumption, 55.7% is used by industrial processes, 21.5% by the residential and commercial sectors, 20.9% by the transport sector and 1.92% in others including the public sector.

The most remarkable feature of Korea's energy consumption is that the non-energy sector (mostly naphtha used as raw material in the petrochemical industry) accounts for 16% which is extremely high compared to 3~4% of developed nations. The rapid growth of Korea's petrochemical industry increased the consumption of naphtha to an average annual of 18.5% between 1990 and 1999.

Furthermore, Korea's dependency on imported energy continued to rise from 76.2% in 1985 to 97.2% in 2000. Its dependency on oil from the Middle East remained high and accounted for 72.3% in 1999 while its dependency on imported

natural gas accounted for 52.6% in 2000.

Korea's increasing rate of energy consumption began to slow down after the financial crisis and the ratio of oil began to drop as well. In 1997, oil accounted for 60.4% of the total energy consumption in Korea, however, it dropped to around 50.0% in 2001. In addition, the increasing rate of gasoline consumption is also slowing down in the transport sector.

The growing importance of securing sufficient energy has prompted the Korean government to reinforce its efforts in exploring stable, cost-efficient and durable energy resources. The Korean government is also seeking to expand the infrastructure for the safe supply of natural gas, expand electricity-generating facilities for a stable power supply and stabilize supply by restructuring the power industry. At the same time, the expanded development and use of renewable energy as well as appropriate energy mix usage are being pursued for the efficient use of energy.

9. Transport

The number of passengers utilizing Korea's transportation systems shows a rapid increase in the use of subways and domestic aviation, moderate increase in the use of railways and roads and

none in aviation. The high increase in the use of domestic aviation is a phenomenon characteristic of the high increase in national income. The increasing number of passengers taking the subway is due to the continual expansion of subway lines as a highly convenient public transportation in metropolitan areas. The number of passengers being transported by each mode of transportation indicates a continual drop in the use of roads whereas the number of passengers taking the subway is rising. It would be reasonable to surmise that the reduction in passenger travel by road is due to the growing number of subway passengers.

The characteristics of Korea's freight transportation can be summarized as high increase in domes-

〈Table 2-12〉 Progress of Korea's Passenger Transportation

(Unit: 1,000,000 persons)

Year	Rail	Subway	Road	Water	Air	Total
1980	431	65	8,039	9	1	8,545
1990	645	1,102	12,722	8	11	14,488
1995	790	1,693	11,290	9	21	13,803
2000	814	2,235	10,411	10	23	13,492
2001	912	2,527	9,857	9	22	13,328

Source: Ministry of Construction & Transportation, *Yearbook of Construction & Transportation Statistics*, Various Volumes

〈Table 2-13〉 Progress in Korea's Freight Transportation

(Unit: 1,000,000 tons · km)

Year	Rail	Road	Water	Air	Total
1980	10,798	4,920	7,463	5	23,185
1990	13,663	9,325	21,127	72	44,187
1995	13,838	18,213	43,936	123	76,110
2000	10,803	11,412	38,298	167	60,680
2001	10,492	12,322	40,876	168	63,858

Source: Ministry of Construction & Transportation, *Yearbook of Construction & Transportation Statistics*, Various Volumes

〈Table 2-14〉 Car Ownership

(Unit: 1,000 Cars)

Year	Passenger Car	Bus	Truck	Special Car	Total
1980	249 (153)	42	226	9	528
1990	2,074 (21)	383	924	11	3,395
1995	6,006 (7.5)	612	1,816	33	8,469
2000	8,084 (5.8)	1,428	2,511	37	12,060
2001	8,889 (5.3)	1,257	2,511	37	12,694

Source: Ministry of Construction & Transportation, *Yearbook of Construction & Transportation Statistics*, Various Volumes
Note: Numbers in parenthesis indicate the number of persons per automobile.

tic shipping, or aviation, moderate increase in public roads and none in railways. Marine freight transport has increased seven fold from around 19 million tons in 1980 to 141 million tons in 2000. Korea's geographical advantage of being surrounded by the sea on three sides has prompted high growth in maritime transport. The slowdown in the increase rate of railway transportation is due to its competition with road transportation. The freight transportation volume in ton-km indicates marine freig-ht transportation to be the highest at 38.298 billion tons in 2000 with a 63% burden rate which acco-unts for 2/3 of the total volume of freight transport. The burden rate of railway transportation is notably low whereas the burden rates of transportation by road and air show a continuing increa-se (Table 2-13).

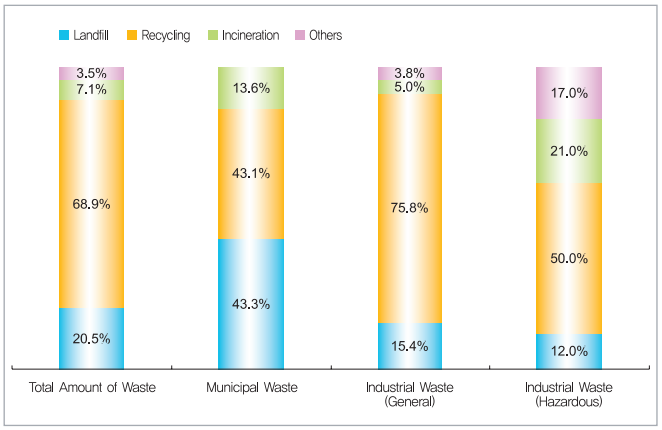
Rapid economic growth and increase in personal income have led to a sharp growth in the demand for transportation. The number of cars has increased from 127,000 in 1970 to 12,694,000 in 2001, recording a 100-fold growth in thirty years. Among cars that are used for various purposes (private, official or business), the increase rate of private passenger cars recorded the highest. The number of privately owned cars increased at a moderate

pace from 61,000 in 1970 to 249,000 in 1980. After 1985, however, the number rapidly increased to 8,889,000 by 2001 which meant fewer people per each car. The number of people per car was 531 in 1970, 153 in 1980, 21 in 1990 and under 6 in 2001.

10. Waste

Korea's industrial structure and consumption pattern together with economic growth generate a considerable amount of waste, a side effect of mass production and consumption. Waste cannot be resolved through nature's self-purification process and has become a serious social and environmental issue. High population density as well as the cultural norm of preparing a table full of food for each meal have produced excessive food waste, an overall social issue which requires the implementation of a resource recycling social system.

The amount of waste generated in Korea has been gradually increasing since 1993. Although municipal waste has been slowly reducing since the 1990s, the amount of industrial waste (general waste and hazardous waste), which has been increasing at a high rate of over 10% every year, surpassed that of municipal waste in 1993. The implementation of government policies has reduced the per capita waste production from 1.3 kg in 1994 to 1.01 kg in 2001. However, the amount of industrial waste generated continues to surge.



[Figure 2-6] Waste Treatment Status (2001)

In the treatment of waste, there has been a large reduction in the use of landfills and increase in recycling. The rate of waste incineration is gradually increasing. In 1999, 89.2% of municipal waste was buried in landfills and 7.9% recycled, however, the amount of waste buried in landfills was reduced to 43.3% and the amount recycled increased to 43.1% in 2001. Furthermore, combustible waste accounts for 59.1% of municipal waste with an incineration rate of only 13.6%.

〈Table 2-15〉 Status of Waste Produced in Korea

(Unit: 1,000 tons/day)

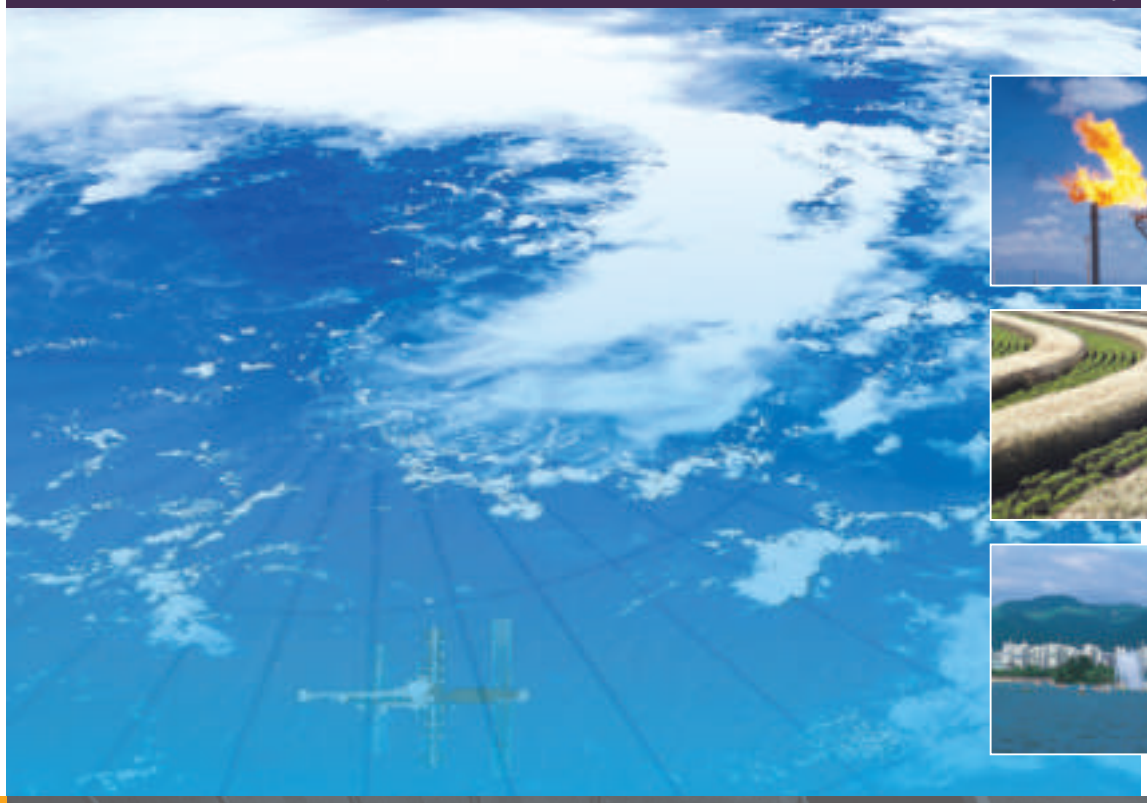
Classification		1993	1994	1995	1996	1997	1998	1999	2000	2001
Total		141.4	147.1	148.1	180.8	194.7	188.6	219.2	234.1	260.4
Municipal		62.9	58.2	47.8	49.9	47.9	44.6	45.6	46.4	48.4
Industrial	General	56.0	85.2	95.8	125.4	141.3	138.7	166.1	180.2	204.4
	Hazardous	23.4	3.7	4.5	5.5	6.1	5.3	7.5	7.6	7.6

Source: Ministry of Environment, *Environment White Paper*, Various Volumes

Note: 1) In 1994, adjustments were made in the waste classification system which converted 80% of the hazardous waste into general industrial waste.

2) The increase of general industrial waste in 1996 was caused by the increase in the number of reports followed by stronger management of construction waste.

3) The 2001 figure for hazardous waste is indicated by 2000 statistics.



Chapter 3 Greenhouse Gas Inventory

Chapter 3 Greenhouse Gas Inventory

1. Outline

The Parties to the UN Framework Convention on Climate Change are required to develop national inventories on national emissions and removals of greenhouse gases using comparable methodologies. This chapter summarizes data on Korea's anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol. It also shows the annual inventories of 2001 and trend analysis on the emissions and removals of the six greenhouse gases covered by the Kyoto Protocol: CO_2, CH_4, N_2O, HFCs, PFCs and SF_6. Trend analysis of greenhouse gas inventories during 1990 and 2001 shows Korea's effort to reduce emissions of greenhouse gases.

Although Korea is not an industrialized countries assigned greenhouse gas emission reduction targets, Korea has made great efforts in preparing an inventory of greenhouse gas emissions and removals along with efforts to reduce its own emissions of greenhouse gases.

2. Greenhouse Gas Inventory in 2001

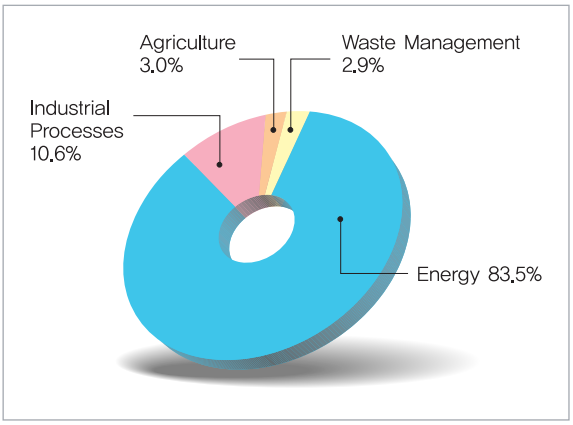
In accordance with the revised 1996 edition of *IPCC Guideline*,[4] IPCC Tier 1 methodology was adapted in compiling the national greenhouse gas emissions inventory. For sectors requiring more detailed inventory, emissions from aviation, power generation, PFCs and SF_6 used in the production process of semiconductors and enteric fermentation in livestock was estimated by using the Tier 2 methodology.

In 2001, total greenhouse gas emissions recorded 148.0 million tons of carbon (MtC),[5] 2.6% increase from 144.3 MtC in 2000, palpably caused by the increase in energy consumption.[6] The energy sector was a major contributor to this increase at 104.2% while industrial processes, agriculture and waste contributed -3.5%, -3.0% and 2.2%, respectively.

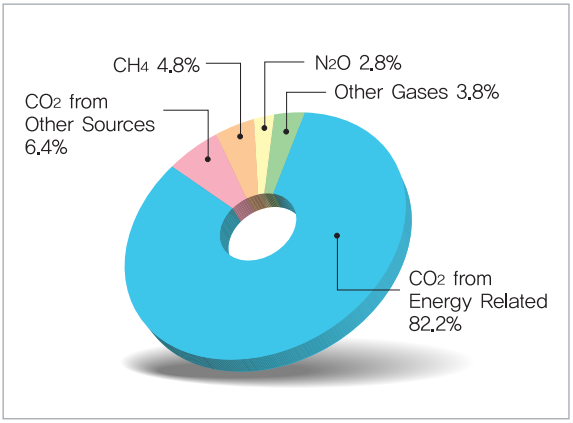
As for greenhouse gas emissions in 2001 by source, energy accounted for 83.5%, industrial

Greenhouse Gas(GHG) Emissions, 2001

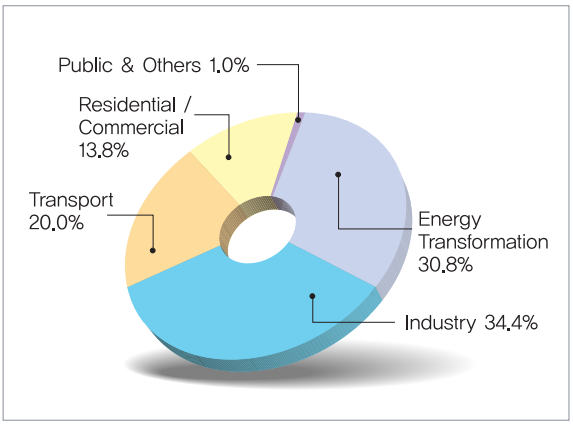
Total GHG Emissions (MtC)	148.0
Increase based on previous year (MtC)	3.6
Growth rate based on previous year (%)	2.6
Net GHG Emissions (MtC)	138.6
Increase based on previous year (MtC)	4.5
Growth rate based on previous year (%)	3.3
Removals of GHG (MtC)	9.4



[Figure 3-1] Greenhouse Gas Emissions by Source (2001)



[Figure 3-2] Greenhouse Gas Emissions by Gas (2001)



[Figure 3-3] Greenhouse Gas Emissions from Fuel Combustion by Sector (2001)

4) The Intergovernmental Panel on Climate Change (IPCC) recommends the application of *IPCC Guideline 1996 Revised Version* and *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* as the methodology for preparing greenhouse gas inventory.
5) Emissions/removals from land-use change and forestry have not been reflected.
6) The Korea Energy Economics Institute (KEEI) compiles and analyzes the inventories of greenhouse gas emissions prepared by the responsible agencies for each sector: the Korea Energy Economics Institute for energy & industrial processes; the National Institute of Agricultural Science & Technology and National Livestock Research Institute for agriculture; the Korea Forest Research Institute for land-use change and forestry; and the Environment Management Corporation for waste management.

processes 10.6%, waste 2.9% and agriculture 3.0% (Figure 3-1). Among the emitted greenhouse gases, energy related carbon dioxide accounted for 82.2% of total emissions, whereas carbon dioxide emissions from other sources accounted for 6.4% (Figure 3-2).

A. Fuel Combustion

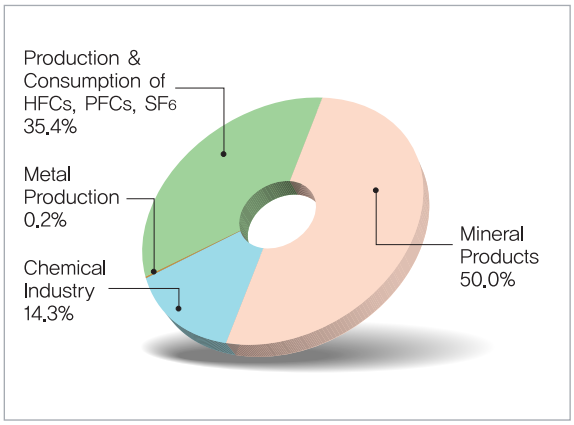
The greenhouse gas emissions from fuel combustion totaled 122.3 MtC, a 3.3% increase from the previous year. The increase is largely attributable to energy transformation followed by the industrial processes and transport. The carbon dioxide emitted from fuel combustion was 121.8 MtC, a 3.3% increase from the previous year, whereas the greenhouse gas intensity was 0.62 tC/TOE, a 0.4% increase from the previous year.

B. Fugitive Emissions

The fugitive greenhouse gas emissions recorded a 4.8% increase from the previous year to 1.3 MtC. Fugitive emissions from coal mining saw a reduction of 292,200 tons of carbon(tC) from the previous year, caused by the reduction of coal production. Despite a reduction in the import of crude oil and the amount processed through refineries, fugitive emissions from oil and natural gas systems increased about 9.4% from the previous year to 966,700 tC, caused mainly by the increase in the import of liquified natural gas.

C. Industrial Processes

The greenhouse gas emissions from industrial processes fell 0.8% from the previous year to 15.8 MtC. The growth rate indicates an increase in mineral production and consumption of HFCs, PFCs and SF_6. However, the overall reduction is attributed to the decline in the chemical industry and metal production.

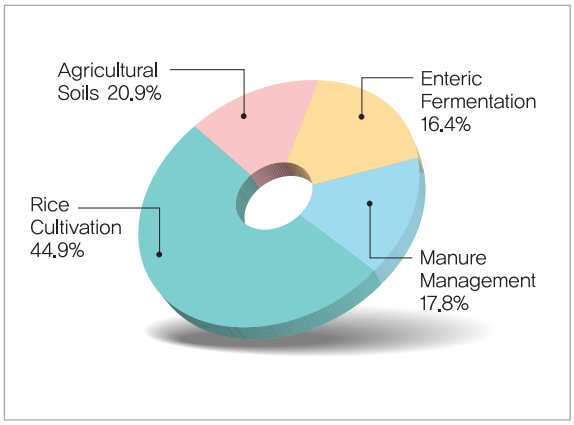


[Figure 3-4] Greenhouse Gas Emissions from Industrial Processes by Source (2001)

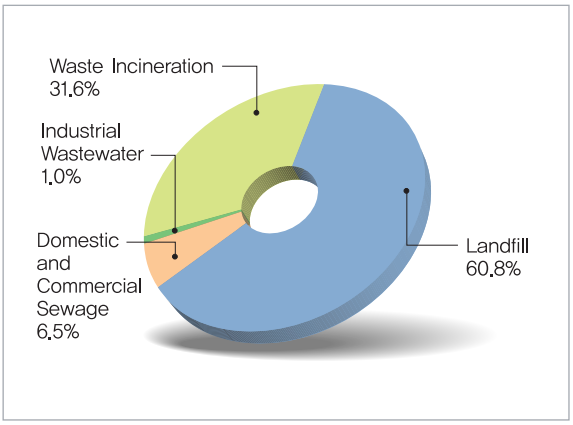
D. Agriculture

The agriculture sector produced 4.4 MtC of greenhouse gas, a 2.5% reduction from the previous year in line with the reduction of emissions from rice cultivation and livestock breeding. The emissions of methane from rice cultivation recorded 2.0 MtC and the emission of nitrous oxide from the use of nitrogenous fertilizers read 0.9 MtC.

Enteric fermentation and manure management from livestock emitted 0.8 MtC of methane, a 5.6% reduction from the previous year, while the amount of nitrous oxide from manure management showed very little change due to a stable number of dairy cattle and a reduced number of beef cattle.



[Figure 3-5] Greenhouse Gas Emissions from Agriculture by Source (2001)



[Figure 3-6] Greenhouse Gas Emissions from Waste by Source (2001)

E. Waste

Regarding the estimated greenhouse gas emissions from waste, Tier 1 methodology was adapted to methane produced by landfills and carbon dioxide and methane from waste incineration were based on actual measurements taken from a major facility. Anaerobic management facility for treatment of sludge and wastewater was newly added for projecting emissions from wastewater[7].

Out of the total 4.3 MtC of greenhouse gases emitted from waste, methane from landfills accounted for 2.6 MtC, methane and nitrous oxide from domestic and commercial sewage 283,000 tC, methane and nitrous oxide from industrial wastewater 45,000 tC and carbon dioxide and nitrous oxide from waste incineration 1.4 MtC.

F. Land-Use Change & Forestry

The net removals from land-use change and forestry show that approximately 9.4 MtC of carbon dioxide gas has been absorbed in this category.

〈Table 3-1〉 Emissions / Removals by Land-Use Change & Forestry (2001)

Greenhouse Gas Source & Sink Categories	CO_2 Emissions	CO_2 Removals	CO_2 Net Emissions/Removals
	(1,000 tC)		
Total	2,121	(−)11,569	(−)9,448
A. Changes in Forest and Other Woody Biomass Stocks	959	(−)11,569	(−)10,610
B. Forest & Grassland Conversion	88	0	88
C. Abandonment of Managed Land	NE	NE	NE
D. CO_2 Emissions & Removals from Soil	1,074	0	1,074
E. Others	NE	NE	NE

Note: (−) sign denotes net removals.

7) In the case of wastewater, projected emissions factor or Methane Correction Factor (MCF) and projections for determining Fraction of Wastewater Treated by Certain Handling System (WS) are required. However, the results are based on limited research and therefore accurate national statistics are difficult and limited. Futhermore, More detailed research is required for industrial wastewater.

〈Table 3-2〉 Summary of Greenhouse Gas Emissions (2001)

Greenhouse Gas Source & Sink	CO_2 Emission	CO_2 Removal	CH_4	N_2O	HFCs	PFCs	SF_6	Net Emissions
	(1,000 tons of CO_2)		(1,000 tons of CH_4)	(1,000 tons of N_2O)	(1,000 tons of CO_2)			(1,000 tC)
Total Greenhouse Gas Emissions & Removals	488,761	−42,420	1,236	50	5,768	2,141	12,567	138,590
1. Energy	446,411		263	3				123,540
A. Fuel Combustion (Sectoral)	446,411		43	3				122,282
1. Energy Industries	137,760		0	1				37,632
2. Manufacturing & Construction	141,623		10	1				38,804
3. Transport	89,050		15	1				24,432
4. Mining/Agriculture, Forestry & Fishing/Residential & Commercial/Public & Others	77,977		18	1				21,413
5. Others	NO		NO	NO				0
B. Fugitive Emissions	0		220	0				1,259
1. Coal	0		51	0				292
2. Oil & Natural Gas	0		169	0				967
2. Industrial Processes	29,817		20	23	5,768	2,141	12,567	15,755
A. Mineral Products	28,898		0					7,881
B. Chemical Industry	779		20	23	NO	NO	NO	2,251
C. Metal Production	140		NE			NO	NO	38
D. Other Production								0
E. Production of HFCs, PFCs, SF_6					556.9	NO	NO	152
F. Consumption of HFCs, PFCs, SF_6					5,211	2,141	12,567	5,433
G. Others	NO		NO	NO	NO	NO	NO	0
3. Solvent & Other Production Use	NE			NE				0
4. Agriculture	NE	NE	487	19				4,405
A. Enteric Fermentation			126					722
B. Manure Management			15	8				784
C. Rice Cultivation			346					1,980
D. Agricultural Soils	NE	NE	NE	11				919
5. Land-Use Change & Forestry (Sinks)	7,777	−42,420						−9,448
A. Changes in Forest and Other Woody Biomass Stocks	3,516	−42,420						−10,610
B. Forest & Grassland Conversion	324	0	NO	NO				88
C. Abandonment of Managed Land	NE	NE						0
D. CO_2 Emissions & Removals from Soil	3,938	0						1,074
E. Others	NE	NE	NE	NE				0
6. Waste	4,756		465	4				4,337
A. Solid Waste Disposal on Land	NE		461					2,639
B. Domestic Sewage Treatment			2	3				283
C. Industrial Wastewater Treatment			2	0				45
D. Waste Incineration	4,756		0	1				1,370
E. Others	NO		NO	NO	NO	NO	NO	0

The records indicate the removal of 10.6 MtC from changes in forest and other woody biomass stocks[8], whereas 88,000 tC and 1.1 MtC were emitted respectively from forest and grassland conversion and CO_2 emissions and removals from soil.

3. Trend of Greenhouse Gas Emissions (1990~2001)

The trend of total greenhouse gas emissions between 1990 ~ 2001 indicates an average annual increase of 5.2% from 84.7 MtC in 1990 to 148.0 MtC in 2001 with per capita emission rising 4.3% per year since 1990 recording 3.13 tC in 2001.

On the other hand, according to the greenhouse gas intensity, an indicator of greenhouse gas emissions per unit GDP, the rise during the early 1990s have begun to fall since 1996. The greenhouse gas intensity fell by 0.6% per year from 0.322 tC per million won in 1990 to 0.300 tC per million won in 2001.

Greenhouse gas emissions increased 5.6% per year from 67.6 MtC in 1990 to 123.5 MtC in 2001 from fuel combustion and fugitive emissions in the energy sector. The 10.2% yearly growth rate in in-

Greenhouse Gas Emissions, 2001

2001 total GHG Emissions (MtC)	148.0
Increase from 1990 level(MtC)	63.3
Average annual growth rate, 1990~2001(%)	5.2
2001 net GHG Emissions (MtC)	138.6
Increase from 1990 level(MtC)	60.3
Average annual growth rate, 1990~2001(%)	5.3
2001 removals of GHG (MtC)	9.4

〈Table 3-3〉 Major Indicators of Total Greenhouse Gas Emissions

	1990	1995	1998	1999	2000	2001	1990-2001 Average Annual Growth Rate (%)
Total GHG Emissions (1,000 tC)	84,738	123,445	123,974	135,542	144,259	148,038	5.2
Per Capita GHG Emissions(tC per capita)	1.98	2.74	2.68	2.91	3.07	3.13	4.3
GHG / GDP (tC per million won,'95)	0.322	0.327	0.314	0.310	0.301	0.300	-0.6

8) Inventory covers all forest areas in Korea and carbon pools of above- and below-ground biomass.

〈Table 3-4〉 Greenhouse Gas Emissions by Source (1990~2001)

(Unit: 1,000 tC)

	1990	1995	1998	1999	2000	2001	1990-2001 Average Annual Growth Rate (%)
Total Emissions	84,738 (100.0)	123,445 (100.0)	123,974 (100.0)	135,542 (100.0)	144,259 (100.0)	148,038 (100.0)	5.2
Energy	67,567 (79.7)	101,490 (82.2)	102,335 (82.5)	111,528 (82.3)	119,601 (82.9)	123,540 (83.5)	5.6
Industrial Processes	5,428 (6.4)	12,747 (10.3)	12,393 (10.0)	14,933 (11.0)	15,886 (11.0)	15,755 (10.6)	10.2
Agriculture	4,798 (5.7)	4,917 (4.0)	4,821 (3.9)	4,656 (3.4)	4,519 (3.1)	4,405 (3.0)	−0.8
Land-Use Change & Forestry (Sinks)	(−)6,476	(−)5,793	(−)9,949	(−)10,422	(−)10,156	(−)9,448	3.5
Waste	6,945 (8.2)	4,291 (3.5)	4,425 (3.6)	4,425 (3.3)	4,254 (2.9)	4,337 (2.9)	−4.2
Net Emissions	78,262	117,651	114,025	125,120	134,102	138,590	5.3

Note: (−) sign denotes net removals.

dustrial processes since 1990 showed close to a three-fold increase from 5.4 MtC in 1990 to 15.8 MtC in 2001.

Emissions from agriculture fell 0.8% per year since 1990 to 4.4 MtC in 2001 largely due to the reduction in rice cultivation and fertilizer use and the declining number of livestock since the late 1990s.

Emissions from waste also fell by an annual 4.2% since the early 1990s. Despite the continual rise in removals by sinks in land use change and forestry sector between 1990 and 1999, the figures since then have been maintained at around 10 MtC.

4. Trend of Greenhouse Gas Emissions by Source (1990~2001)

A. Fuel Combustion

The IPCC methodology estimation of carbon dioxide emissions from fuel combustion showed a high rise in the 1980s. However, the figure appeared to increase annually by 5.8% from 1990 to 2001. Over the same period, carbon dioxide emissions from energy transformation and transport sectors increased by an annual 12.4% and 7.0%, respectively.

Carbon intensity fell 1.2% per year between 1990 to 2001 from 0.699 tC/TOE in 1990 to 0.614 tC/TOE in 2001 due to the reduction in the use of anthracite coal, widespread use of natural gas, further installation of nuclear power facilities, etc. However, inter-fuel substitution to low-carbon fuel attributed to the improvement in carbon intensity.

Emissions of non-carbon dioxide from fuel combustion may be remote; nevertheless, emissions of methane continued to decrease while emi-

〈Table 3-5〉 Major Indicators of Carbon Dioxide Emissions from Fuel Combustion

	1990	1995	1998	1999	2000	2001	1990-2001 Average Annual Growth Rate (%)
CO_2 Emissions (A) (1,000 tC)	65,171	100,056	100,874	109,914	117,876	121,748	5.8
Energy Consumption (B) (1,000 TOE)	93,192	150,437	165,932	181,363	192,887	198,409	7.1
Carbon Intensity(A/B) (tC/TOE)	0.699	0.665	0.608	0.606	0.611	0.614	-1.2

ssions of nitrous oxide increased in line with rising energy consumption.[9] The residential and commercial sectors are the main sources of methane emissions from fuel combustion, and the decline in coal consumption in households and change in combustion method have continued to bring down emissions of methane.

Methane emissions from fuel combustion was comparatively high at 715,700 tC in 1990. However, emissions continually declined each year, significantly decreasing to 248,400 tC in 2001. Meanwhile, emissions of nitrous oxide rose around 1.4 fold from 203,900 tC in 1990 to 284,700 tC in 2001.

B. Fugitive Emissions

The greenhouse gas produced by fugitive emissions is methane which is emitted during the production and handling of coal, oil and gas. Methane is produced during and after production in coal systems and during the storage, conveyance and refining process after production in natural gas and oil systems.

The production of anthracite and reduction of coal consumption attributed to the rapid decline of methane emissions from coal systems in 2001 to 292,000 tC, or 22% of 1990 level. Since there are no natural gas and oil production wells in Korea, methane is emitted during such processes as refining, storage and conveyance through pipelines. Methane emissions from natural gas and oil systems rose to 967,000 tC in 2001, or by 17.8% per year since 1990, in line with increased demand for fuel.

9) The basic Tier 1 Methodology and combustion technology-related Tier 2 Methodology were applied to estimate emissions from power generation in the energy transformation sector.

C. Industrial Processes

Greenhouse gas emissions from industrial processes are highly sensitive to economic fluctuations, and therefore, emissions produced by consumption of HFCs, PFCs and SF_6 and emissions of HFC-23 generated as a by-product of HCFC-22 production are included in the greenhouse gas inventory.

Emissions of carbon dioxide, which accounted for most of the greenhouse gas emissions from industrial processes based on 2001 estimations, increased by an average annual of 4.4% since 1990 to 8.1 MtC in 2001. Over the same period, emissions of methane and nitrous oxide rose steeply by an annual 12.7% and 40.9%, respectively.

HFCs, PFCs and SF_6, which are used in coolants, process gases used in semiconductor manufacturing and circuit breakers for heavy electric machineries, are significant gases accounting for 35.8% of total emissions from industrial processes in 2001. The increasing trend of replacing CFCs in coolants with HFCs and the generation of HFC-23, a by-product of HCFC-22 production, have increased the emission of HFCs by 17.5% per year. Meanwhile, the emissions of PFCs fell by 0.4% per year since 1997 which may be the outcome of the agreement to reduce consumption of PFCs at the Semiconductor Industry Association Conference.

D. Agriculture

Methane and nitrous oxide emissions from agriculture are directly affected by land used for rice cultivation, amount of fertilizer used, number of livestock, etc. The area of land under rice cultivation showed a reduction from 1.233 million hectares in 1990 to 1.083 million hectares in 2001. Rice fields using intermittent irrigation, which produces relatively high methane emissions, are gradually declining. As a result, methane emissions in rice fields fell 1.5% per year from 2.4 MtC in 1990 to 2.0 MtC in 2001. The reduction in the use of nitrogenous fertilizers had brought down emissions of nitrous oxide by a yearly 2.1% from 1.2 MtC in 1990 to 0.9 MtC in 2001.

Although the number of livestock has decreased since the late 1990s, greenhouse gas emitted from enteric fermentation and manure management showed a slow increase. Methane emitted by enteric fermentation rose 0.2% per year from 704,000 tC in 1990 to 722,000 tC in 2001. Over the same period, methane and nitrous dioxide emissions from manure management rose 2.6% per year from 588,000 tC to 784,000 tC.

E. Waste

Greenhouse gas emissions from waste include methane emitted from landfills, methane and nitrous oxide from wastewater, and carbon dioxide and nitrous oxide from waste incineration.

The increase in generated amount of waste, which determines greenhouse gas emissions,

began to slow since the mid-1990s due to stronger waste management policies. Most urban solid and industrial wastes in Korea are disposed in landfills with residential solid waste accounting for 56.2% and industrial waste 25.2%.

The increasing trend of domestic sewage and industrial wastewater showed an annual increase of 2.0% from 14,000 m^3/day in 1990 to 17,111 m^3/day in 2000 and wastewater by 2.1% from 3,446 m^3/day in 1990 to 4,068 m^3/day in 1998.

F. Land-Use Change & Forestry

During the last decade, the net removals from change in forest and other woody biomass stocks increased along with the steady increase of forest growth and low level of harvesting. On the other hand, progress in urbanization led to increase in carbon dioxide emissions from soil due to land-use change, nevertheless the increase is minimal compared to the net removal from changes in forest and other woody biomass stocks. As such, the total net removal from land-use change and forestry increased 3.5% per year from 6.5 MtC in 1990 to 9.4 MtC in 2001.

G. International Bunkering & Biomass

In international bunkering, emissions from aviation showed a high annual increase rate of 14.2% and emissions from marine transport rose by 12.8% since 1990. Greenhouse gas emissions from biomass rose 10.4% per year since 1990.

〈Table 3-6〉 Greenhouse Gas Emissions/Removals from Land-Use Change & Forestry (Sinks)

(Unit: 1,000 tC)

	1990	1995	1998	1999	2000	2001	1990-2001 Average Annual Growth Rate (%)
Total	(−)6,476	(−)5,793	(−)9,949	(−)10,422	(−)10,156	(−)9,448	3.5
Changes in Forest & Other Woody Biomass Stocks	(−)7,155	(−)6,867	(−)11,087	(−)11,552	(−)11,299	(−)10,610	3.6
Forest & Grassland Conversion	46	71	82	84	84	88	6.0
Abandonment of Managed Land	NE	NE	NE	NE	NE	0	
CO_2 Emissions & Removals from Soil	633	1,003	1,057	1,046	1,059	1,074	4.9

Note: (−) sign denotes net removals.

〈Table 3-7〉 Korea's Greenhouse Gas Inventory and Trends (1990~2001)

(Unit: 1,000 tC)

	1990	1995	1997	1998	1999	2000	2001
Total Emissions (Source)	84,738	123,445	143,994	123,974	135,542	144,259	148,038
Net Emissions (Source & Sink)	78,262	117,651	135,566	114,025	125,120	134,102	138,590
1. Energy	67,567	101,490	118,530	102,335	111,528	119,601	123,540
A. Fuel Combustion (Sectoral)	66,090	100,604	117,475	101,343	110,413	118,400	122,282
1. Energy Industries	10,365	22,691	30,717	25,910	28,707	34,333	37,632
2. Manufacturing & Construction	22,373	33,868	38,343	35,920	37,329	38,680	38,804
3. Transport	11,574	21,044	23,705	20,099	21,942	23,770	24,432
4. Mining/Agriculture, Forestry & Fishing/Residential & Commercial/Public & Others	21,779	23,001	24,709	19,414	22,434	21,617	21,413
5. Others	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions	1,477	885	1,056	992	1,116	1,201	1,259
1. Coal	1,318	438	345	334	321	318	292
2. Oil & Natural Gas	159	448	711	658	794	883	967
2. Industrial Processes	5,428	12,747	15,813	12,393	14,933	15,886	15,755
A. Mineral Products	4,852	8,435	8,820	7,095	7,326	7,617	7,881
B. Chemical Industry	280	1,173	1,282	1,669	1,941	2,127	2,251
C. Metal Production	27	38	46	36	34	39	38
D. Other Production	0	0	0	0	0	0	0
E. Production of HFCs, PFCs, SF_6	268	712	888	530	993	883	152
F. Consumption of HFCs, PFCs, SF_6	0	2,389	4,777	3,065	4,639	5,220	5,433
G. Others	NO	NO	NO	NO	NO	NO	NO
3. Solvent & Other Production Use	NE	NE	NE	NE	NE	NE	NE
4. Agriculture	4,798	4,917	4,910	4,821	4,656	4,519	4,405
A. Enteric Fermentation	704	1,023	1,058	970	858	771	722
B. Manure Management	588	812	856	832	799	782	784
C. Rice Cultivation	2,349	1,992	1,931	1,962	1,957	1,967	1,980
D. Agricultural Soils	1,157	1,090	1,065	1,057	1,042	999	919
5. Land-Use Change & Forestry (Sinks)	−6,476	−5,793	−8,428	−9,949	−10,422	−10,156	−9,448
A. Changes in Forest and Other Woody Biomass Stocks	−7,155	−6,867	−9,564	−11,087	−11,552	−11,299	−10,610
B. Forest & Grassland Conversion	46	71	79	82	84	84	88
C. Abandonment of Managed Land	NE	NE	NE	NE	NE	NE	NE
D. CO_2 Emissions & Removals from Soil	633	1,002	1,057	1,057	1,046	1,059	1,074
E. Others	NE	NE	NE	NE	NE	NE	NE
6. Waste	6,945	4,291	4,740	4,425	4,425	4,254	4,337
A. Solid Waste Disposal on Land	6,400	3,383	3,654	3,339	3,191	2,793	2,639
B. Domestic Sewage Treatment	288	282	283	281	282	279	283
C. Industrial Wastewater Treatment	51	59	49	47	50	45	45
D. Waste Incineration	206	567	755	758	902	1,137	1,370
E. Others	NO	NO	NO	NO	NO	NO	NO

5. Trend of Greenhouse Gas Emissions by Gas (1990~2001)

A. Carbon Dioxide

The total carbon dioxide emissions in 2001 increased 5.8% per year since 1990 to 131.2 MtC, an 86.2% rise from the 1990 level (60.7 MtC) and 3.4% rise from the 2000 level (4.4 MtC).

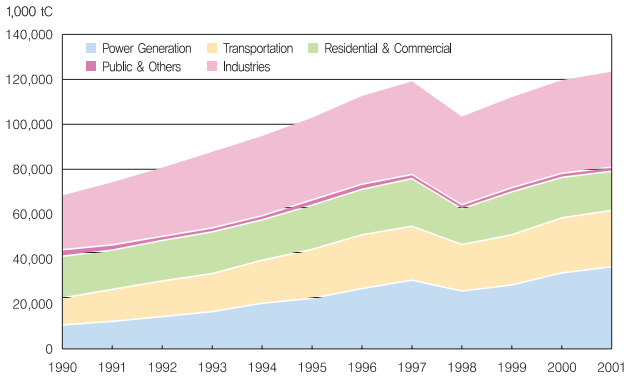
Emissions of carbon dioxide from fossil fuel combustion in 2001 recorded 121.8 MtC based on IPCC Methodology estimations made since 1990 and emissions from industrial processes, waste incineration, etc. recorded 9.4 MtC. Meanwhile, the net removals of carbon dioxide by land-use change and forestry rose by an annual 3.9% from 6.5 MtC in 1990 to 9.9 MtC in 2001.

Carbon dioxide from fuel combustion, which accounted for 83% of the total greenhouse gas emissions in 2001, indicated a high increase in the 1980s and continued to rise during the early 1990s recording a yearly growth rate of 5.8%, from 65.2 MtC in 1990 to 121.8 MtC in 2001.[10)]

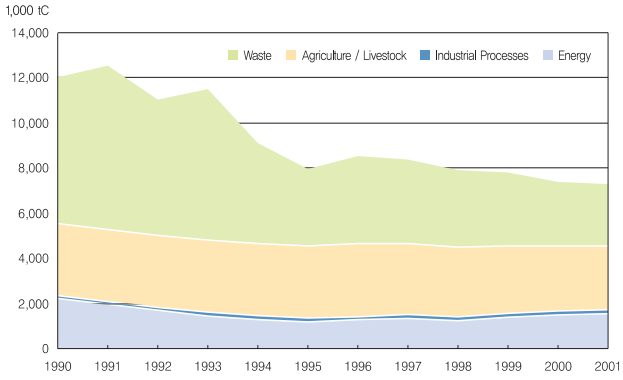
Carbon dioxide emissions from fuel combustion in power generation and transportation sectors annually rose by 12.1% and 7.0% respectively which are relatively higher than other sectors. The high emissions of carbon dioxide from power generation is largely attributable to the expansion of bituminous coal-fired power generating facilities. Power generation accounted for about 30% of the carbon dioxide emissions from fuel combustion in 2001, whereas transportation accounted for 20%, industrial processes 34%, residential and commercial 14% and others including public use contributing to the rest.

B. Methane

Methane emissions in 2001 fell to 1.8% below the 2000 level, or 7.1 MtC. This reduction was largely attributed to improvements in the waste management sector. Emissions of methane fell 4.5% per year since 1990. The reduction in methane emissions is due to the slowing energy sector along with the ordinarily high methane-producing waste and agriculture sectors. That is, the amount of waste being produced have decreased since the mid-1990s after the implementation of stronger waste management policies. The reduction of coal consumption and change in combustion method in the residential and commercial sectors also con-



[Figure 3-7] Trend of Carbon Dioxide Emissions from Fuel Combustion by Source

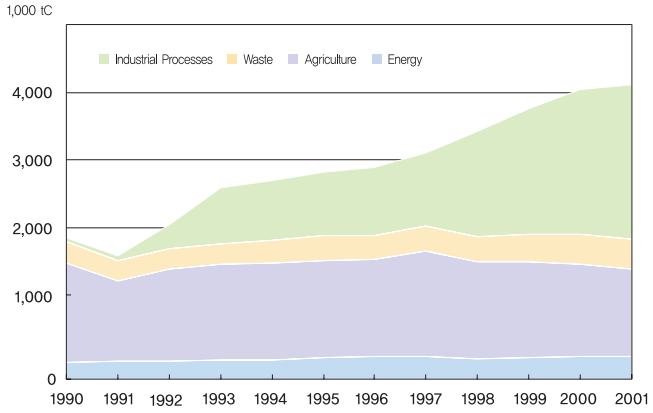


[Figure 3-8] Trend of Methane Emissions by Source

10) The emissions/removals from land use change and forestry have not been reflected in the total carbon dioxide emissions.

tributed to the decrease of methane emissions. However, methane emissions from fuel combustion continued to maintain a relatively low increasing trend since the mid-1990s.

The rate of increase in methane emissions since 1990 recorded -7.7% in waste, -1.0% in agriculture, -3.4% in energy and 12.7% in industrial processes. The rise in emissions from industrial processes may be due to the increase in petro-chemical facilities.



[Figure 3-9] Trend of Nitrous Oxide Emissions by Source

C. Nitrous Oxide

The emissions of nitrous oxide in 2001 rose 1.3% above the 2000 levels, or 4.2 MtC. The increase in nitrous oxide emissions is largely attributable to industrial processes. Nitrous oxide emissions from the waste and energy sectors increased slightly while emissions from the agriculture sector declined slightly. The increase in nitrous oxide emissions from industrial processes was due to the recent expansion of the petro-chemical industries.

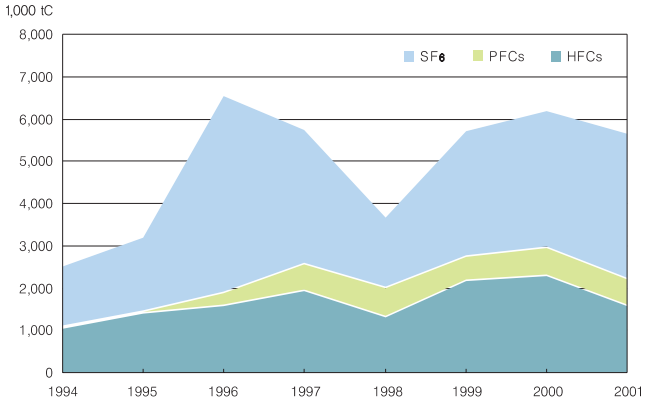
Nitrous oxide emissions from agriculture are largely due to the use of nitrogenous fertilizers and manure management. The use of nitrogenous fertilizers have fallen gradually in recent years and emissions from manure management remained almost the same since 2000. Emissions from domestic sewage, industrial wastewater and waste incineration in the waste sector have increased.

Emissions of nitrous oxide rose by an annual 6.0% since 1990; by source, recording an average annual growth rate of 40.9% in the industrial processes, -0.3% in agriculture, 3.1% in energy and 1.9% in waste.

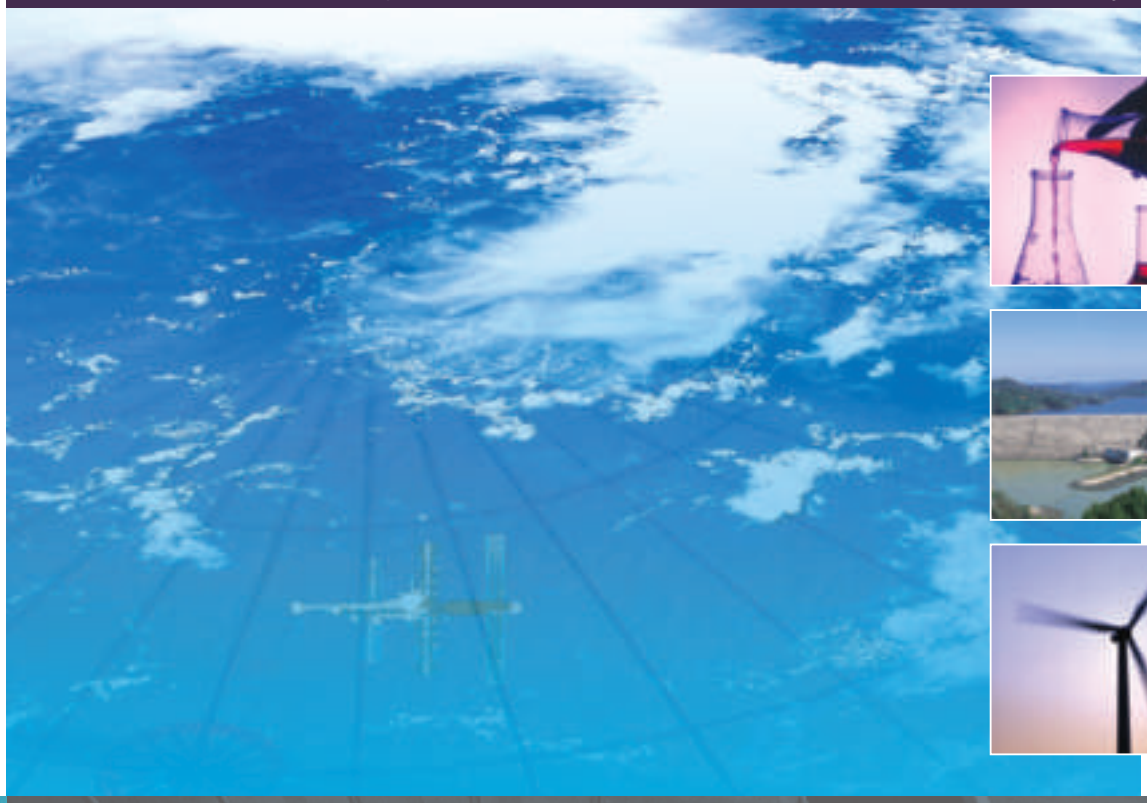
D. Other Greenhouse Gases (HFCs, PFCs, SF_6)

The emissions of HFCs, PFCs and SF_6 in 2001 fell 8.5% below 2000 levels to 5.6 MtC. HFC-23 is emitted as a by-product of the production process of HCFC-22, and HFCs are mainly used as coolants contained in appliances and cars. PFCs are exclusively used in semiconductor manufacturing processes such as plasma etching and chamber cleaning. And 80% of SF_6, which is usually used as the insulation medium of heavy electric machineries and used in etching silicon for semiconductors, is used as insulator of heavy electric machineries in Korea.

The emissions of SF_6 increased in 1996 possibly due to an unusual increase in the use of heavy electric machineries, and the decline in HFC emissions in 2001 may have been caused by a fall in HCFC-22 production.



[Figure 3-10] Trend of HFCs, PFCs, SF_6 Emissions



Chapter 4 Policies and Measures

Chapter 4

Policies and Measures

1. Basic Direction and Promotional Strategy

Recognizing that the conservation of energy and reduction of greenhouse gases not only contribute to international cooperation but are also consistent with the long-term development goals of the Korean economy, the various policies and measures related to energy conservation and reduction of greenhouse gas emissions as advocated in the UN Framework Convention on Climate Change (UNFCCC) have been established in Korea. An Inter-Ministerial Committee on UNFCCC was established in 1998 to formulate, implement and promote the Comprehensive Action Plans for UNFCCC.

Accelerated development of advanced industries that are less energy-intensive such as the IT industry and other high-tech industries and active energy conservation efforts in all sectors will enable the early establishment of an economic structure that prioritizes energy conservation. This will reflect Korea's basic policy direction and measures for greenhouse gas reduction to contribute to the global efforts to mitigate climate change.

Through the First Comprehensive Action Plan (1999 ~ 2001) in 1998, Korea has succeeded in acc-

〈Table 4-1〉 Promotional Strategies of Policies & Measures for GHG Reduction in Korea

Promotion of Technology to Reduce GHG & Development of Environment-Friendly Energy	• Designate GHG-reducing technology as one of the prospective environmental technologies to promote R&D. • Create a market demand for renewable energy by reinforcing the efforts to develop cleaner environment-friendly energy.
Strengthening of Policies and Measures for GHG Reduction	• Reinforce energy conservation efforts through integrally managed energy conservation policies and improve efficiency in energy usage. • Fortify energy conservation policies for the residential and commercial sectors by reinforcing energy efficiency standards for buildings & insulation level of building envelope and expanding the Energy Efficiency Labeling Program. • Conserve transportation fuel consumption by promoting cleaner alternative fuel and compact cars. • Reinforce GHG-reduction policy in the transport sector through efficient management of major transportation networks and traffic demand, establishment of a comprehensive logistics information network and standardization of logistics equipment. • Reinforce GHG-reduction policy by improving the methods of farming and animal husbandry in the agriculture and livestock sectors as well as promoting recycling and minimizing waste. • Conserve and expand forest sinks through afforestation and reforestation projects.
Inducement of Public Participation & Cooperation	• Promote PR and strengthen partnerships with industries and NGOs. • Motivate the public to participate and cooperate in the efforts to reduce GHG emissions by promoting PR and strengthening education programs for students and workers.

omplishing 27 tasks, including voluntary agreements (VA), renewable energy development and raising sewage treatment levels, as well as 111 detailed measures, including support for energy service companies (ESCO) and expansion of forestation projects.

In 2001, the agreement on the implementation plan for the Kyoto Protocol and changes in Korea's economic and industrial circumstances was reflected in the establishment of the Second Comprehensive Action Plan (2002 ~ 2004). The Second Comprehensive Action Plan contains various detailed projects for the reduction of greenhouse gas emission in Korea in three relevant areas: (1) promotion of greenhouse gas reducing technology and development of environment-friendly energy, (2) strengthening policies and measures for greenhouse gas reduction and (3) promotion of public participation and cooperation.

2. Institutional Arrangements

The policies and measures related to UNFCCC in Korea are being established and promoted through the Inter-Ministerial Committee on UNFCCC headed by the Prime Minister and composed of specialists and members of various ministries and government agencies as well as the industrial sector. Through an official order from the Prime Minister in September 2001, the inter-ministerial committee launched in April 1998 to devise systematic measures on UNFCCC, was expanded and modified. The committee consists of a viceministerial level working group chaired by the Deputy Minister of Government Policy Coordination, a coordination working group of director-generals chaired by the economic policy coordinator of the Office for Government Policy Coordination, six task forces for each major field, and five research teams staffed with relevant specialists.

Furthermore, the need to ensure continuous economic development and environmental protection in balance and to actively respond to international environmental issues such as the UNFCCC led to the establishment of the Presidential Commission on Sustainable Development.[11)]

To achieve efficiently integrated and continuously developing economy, society and the environment, the commission functions as a presidential advisory group on matters regarding the nation's major policy directions and plans related to economic development and environmental protection, actions on "Agenda 21" adopted at the 1992 United Nations Conference on Environment & Development (UNCED), and such international environment pacts as UNFCCC. Meanwhile, efficient measures related to the UNFCCC have been devised and are being enforced by the Special Committee on Countermeasures for Climate Change at the National Assembly in March 2001 in the government sector and the Task Force on UNFCCC at the Korea Chamber of Commerce and Industry established in March 2001 for the private economy sector.

3. Synopsis and Promotional Direction

As a party to the UNFCCC, Korea has been voluntarily developing and vigorously promoting various policies and measures to alleviate global warming at all levels of the economy. Such endeavors also contribute to international collaborative efforts to reduce greenhouse gases. Special efforts are being made to accelerate the steering of economic activities to low energy-consuming industries and to conserve energy for the prevention of global warming.

The reduction of greenhouse gases in the energy sector is being promoted by targeting energy supply and demand, heating and cooling of buildings, and transportation fuel. As regards energy demand, greenhouse gas reduction is being made through an integrally managed energy conservation policy and improvements in energy efficiency. For energy supply, policies are being devised to expand the use of renewable and cleaner energy. Futhermore, various policies and measures to improve energy efficiency in buildings, expand the use of clean fuel, and broaden market demand for compact cars are also being formulated.

In the transportation sector, various greenhouse gas reducing efforts are being made through two promotional goals: (1) efficient management of the national transportation system and traffic demand and (2) establishment of comprehensive logistics information network and standardization of logistics apparatus. Greenhouse gas reduction efforts are also being made in the agriculture & livestock sectors by improving farming and animal husbandry methods. As for the waste sector, policies and measures to establish a foundation to minimize waste, increase recycling and expand waste management processes are being implemented. Policies to increase removals and decrease emissions are also being implemented in the forestry sector through efficient management and maintenance of forests and afforestation.

The above promotional strategies for each sector and detailed policies and measures are summarized in (Table 4-2). The main contents of the detailed policies and measures, the targeted greenhouse gases, types of policies and the status of implementation are summarized in (Table 4-3).

11) www.pcsd.go.kr.

〈Table 4-2〉 Summary of Policies and Measures by Sector

Sector		Promotional Strategy	Policies and Measures
Energy	Demand	Integrally Managed Energy Conservation Policy	3-Year Plan for Energy Audit
			Expansion of Voluntary Agreement (VA)
			Energy Service Companies (ESCO)
		Improvements in Energy Efficiency	High Efficient Equipment Certification Program
			Energy Efficiency Standards & Labeling Program
	Supply	Expansion of Renewable & Clean Energy Use	Formation of Market Demand for Renewable Energy and Improvement in Its Economics
			Expansion of Integrated Energy Supply Project
			Stable Supply of Natural Gases
			Stable Supply Level of Nuclear Energy
			Promotion of Landfill Gas (LFG) Projects
	Building	Improvement of Energy Efficiency in Buildings	Mandatory Standards for Building Insulation & Energy-Efficient Designs
			Energy Efficiency Labeling Program for Buildings
			Green Building Certification Program
	Transportation Fuel	Promotion of Clean Fuel & Compact Cars	Promotion of CNG Buses and Compact Cars
			Development of Diesel Cars
Transportation		Efficient Management of National Transportation System & Traffic Demand	Promotion of Efficient Transport Mode Sharing
			Reduction of Traffic Congestion Areas
			Expansion of Public Transportation Service
			Traffic Demand Management
			Regulation on Idle Running Vehicles & Restriction on Car Use
		Establishment of Comprehensive Logistics Information Network & Standardization of Logistics Equipments	Establishment of Comprehensive Logistics Information Network
			Promotion of Logistics Standardization
Agriculture and Livestock		Improvements in Patterns of Farming and Animal Husbandry	Reduction of Methane from Irrigated Rice Paddies and Nitrous Oxide from Uplands
			Improvement in Enteric Management of Ruminant Livestock
			Improvement in Livestock Manure Treatment Facilities
Land-Use Change and Forestry		Forest Management	Promotion of Forest Tending Projects
			Control of Forest Pest Insects and Diseases
			Enforcement of Forest Fire Management System
		Forest Maintenance	Control of Deforestation and Replantation of Harvested Areas
		Afforestation	Promotion of Urban Greening
Waste		Minimization & Recycling of Waste	Waste Minimization
			Waste Recycling
		Establishment of Foundation for Waste Treatment	Municipal Waste Landfill Facilities
			Waste Incineration Facilities
			Sewage & Wastewater Treatment Facilities

Note: VA = Voluntary Agreement, ESCO = Energy Service Company, CNG=Compressed Natural Gas

〈Table 4-3〉 Summary of Detailed Policies and Measures for GHG Reduction by Source

Policies and Measures	Main Contents	Targeted GHG	Type of Policy	Status of Implementation
■ Energy Sector : Energy Demand – Integrally Managed Energy Conservation Policy				
3-Year Plan for Energy Audit	• Execute annual expansion of energy audit targeting energy intensive industries & buildings • Support with low interest policy funds to implement the improvement- necessary items presented in energy audit	CO_2	Voluntary Agreement Financial Support	Implemented
Expansion of Voluntary Agreement (VA)	• Continue expansion and promotion of existing VA to enter agreement with 600 businesses by 2003. In 2004, the second phase agreement will be executed	CO_2 Other gases	Voluntary Agreement	Implemented
Energy Service Companies (ESCO)	• Induce expansion of existing ESCO with financial support	CO_2	Financial Support	Implemented
■ Energy Sector : Energy Demand : Improvements in Energy Efficiency				
High Efficiency Equipment Certification Program	• Expand and support high-efficiency products distribution	CO_2	Regulatory Financial Support	Implemented
Energy Efficiency Standards & Labeling Program	• Gradually expand items for energy efficiency standards & labeling program • Upgrade efficiency standards & expand human resources for follow-ups • Foster professional agencies for the measurement of efficiency	CO_2	Regulatory Financial Support	Implemented
■ Energy Sector: Energy Supply : Expansion of Renewable & Clean Energy Use				
Formation of a Market Demand for Renewable Energy & Improvement in Its Economics	• Secure cost-effective renewable energy by preserving margin from electricity transaction cost • Form test villages to build a supply base for renewable energy • Expand supply & induce spread of renewable energy adequate to the characteristics of the area	All GHGs	Regulatory Financial Support Research	Implemented
Expansion of Integrated Energy Supply Project	• Expand supply range of district heating & cooling services evaluated as having high energy conservation & environmental improvement effect	CO_2	Economic Financial Support	Implemented
Stable Supply of Natural Gases	• Secure stable supply from natural gas producing countries • Construct pipelines & LNG terminals in major cities across the country	All GHGs	Regulatory	Implemented
Stable Supply Level of Nuclear Energy	• Increase supply level of nuclear energy generation for long-term power supply & demand. Successfully implement plan for the operation & construction of nuclear power plant	All GHGs	Regulatory	Implemented
Promotion of Landfill Gas(LFG) Projects	• Promote projects utilizing methane gas from landfills as source of energy for power generating facilities and industrial fuel	CH_4	Financial Support	Implemented

〈Table 4-3〉 Summary of Detailed Policies and Measure for GHG Reduction by Source (continued)

Policies and Measures	Main Contents	Targeted GHG	Type of Policy	Status of Implementation
■ Energy Sector: Buildings				
Mandatory Standards for Building Insulation & Energy-Efficient Designs	• Raise insulation level by over 20% in building sector to minimize energy consumption • Expand mandatory application of new high-efficient energy equipments to building design • Enforce education and promotion for efficient implementation of energy efficiency building design standard	CO_2	Regulatory	Implemented
Energy Efficiency Labeling Program for Buildings	• Increase support for and issuance of Certificate of Building Energy Efficiency (grade 1~3) for buildings above a given energy performance standard • Annually expand applicable buildings	CO_2	Regulatory Financial Support	Implemented
Green Building Certification Program	• Issue certification for buildings that have the capacity to improve environmental performance and reduce energy consumption and GHG emissions through life cycle assessment	CO_2 Air pollutant	Regulatory Financial Support (Planned)	Implemented
■ Transportation Sector: Efficient Management of National Transportation System & Traffic Demand				
CNG Buses	• Mandate the use of low or no pollution emitting vehicles after the Air Quality Preservation Act was revised on Dec. 26, 2002 • Plan to provide 5,000 vehicles by 2003 and replace all buses nationwide (around 20,000) by 2007	CO_2	Regulatory Financial Support	Implemented
Compact Cars	• Provide benefits such as tax reduction, discounts in expressway tolls and public parking for compact cars • The proportion of compact cars reached 8.0% by the end of 2001 and continuous effort is being made to increase the rate	CO_2	Regulatory Financial Support	Implemented
Development of Diesel Cars	• Support development of post-treatment technology and other technologies related to diesel cars. Promote technological development for diesel engine filters and catalyst	CO_2	Regulatory Financial Support	Implemented
■ Transportation Sector: Efficient Management of National Transportation System & Traffic Demand				
Promotion of Efficient Transport Mode Sharing	• Raise mode sharing rate for railway from 7.6% in 1997 to 14.2% in 2004 • Improve mode sharing by establishing Transportation System Efficiency Act	CO_2	Regulatory	Implemented
Reduction of Traffic Congestion Areas	• Improve traffic congested areas through, for example, construction of detours	CO_2	Regulatory	Implemented
Expansion of Public Transportation Service	• Expand urban railroad & light rail transit • At the end of 2001, 127 sections totaling 510.4 km were designated as exclusive bus lanes in 8 cities & provinces	CO_2	Regulatory	Implemented
Traffic Demand Management	• Reduce traffic inducement charge for companies implementing Traffic Demand Management. Implement urban transportation demand management by designating urban traffic congestion special management area, developing traffic control system, limiting parking lot use, etc	CO_2	Regulatory Financial Support	Implemented
Regulation on Idle Running Vehicles & Restrictions on Car Use	• Regulate idle running vehicles through the amendment of Air Quality Preservation Act	CO_2	Regulatory Education	Implemented

〈Table 4-3〉 Summary of Detailed Policies and Measure for GHG Reduction by Source (continued)

Policies and Measures	Main Contents	Targeted GHG	Type of Policy	Status of Implementation
■ Transport Sector : Establishment of Comprehensive Logistics Information Network & Standardization of Logistics Equipments				
Establishment of Comprehensive Logistics Information Network	• Establish and promote the 3rd Comprehensive Logistics Information Network (2002 ~ 2003) to build a comprehensive logistics information network that collectively treats logistics duties	CO_2	Regulatory	Implemented
Promotion of Logistics Standardization	• Improve standards for compatability among logistics related facilities and equipments. Strengthen international collaboration for Korean, Chinese and Japanese logistics standardization • Establish joint target and task allotting system among government institutions for logistics standardization policy	CO_2	Regulatory	Implemented
■ Agricultural and Livestock Sectors: Improvements in Patterns of Farming and Animal Husbandry				
Reduction of Methane from Irrigated Rice Paddies	• Develop and provide technologies for measuring and/or reducing methane from rice paddies • Encourage rice cultivating patterns, water management and varietal improvement	CH_4	Research Education Information	Implemented
Reduction of Nitrous Oxide from Uplands	• Develop and provide technologies for measuring and/or reducing nitrous oxide • Strongly recommend soil tested fertilization • Provide information and promote fertilizer use efficiency	N_2O	Research Education Information	Implemented
Improvement in Enteric Fermentation of Ruminant Livestock	• Develop technologies for measuring and/or reducing level of methane emissions • Reduce methane emissions through enteric improvement of livestock • Increase distribution of high quality forage and add fermentation enhancer in forage	CH_4	Research Financial Support	Implemented
Improvement in Livestock Manure Treatment Facilities	• Develop technologies for measure and/or reducing GHG emissions from livestock manure • Promote the improvement of livestock manure treatment facilities and continually expand investment • Reinforce promotion for the improvement of facility management and operational methods	CH_4	Research Financial Support	Implemented
■ Land-Use Change and Forestry Sectors				
Promotion of Forest Tending Projects	• Expand Forest Tending Project, which was promoted (1998 ~ 2001) with an investment of 646.9 billion won on a 1,024,000 ha forest, to forest of 2,800,000 ha by year 2007	CO_2	Regulatory Voluntary Agreement Financial Support	Implemented
Control of Forest Pest Insects and Diseases	• Prevent the spread of forest insect pests and diseases through early detection • Concentrate diseases and pest insects control on pines which cover over 40% of damaged forest areas	CO_2	Regulatory	Implemented
Enforcement of Forest Fire Management System	• Promote activities for prevention and various promotional campaigns • Establish preparations for rapid forest fire suppression and distribute fire extinguishing equipments • Mandate mutual cooperation by related ministries and offices for efficient prevention and suppression	CO_2, CH_4, NO_2, NOx	Regulatory	Implemented
Control of Deforestation and Replantation of Harvested Areas	• Strengthen deforestation standards through the establishment of Forest-Land Management Law • Provide financial support to induce afforestation of idle land • Legalize mandatory replantation of harvested areas	CO_2	Regulatory Financial Support	Implemented

〈Table 4-3〉 Summary of Detailed Policies and Measure for GHG Reduction by Source (continued)

Policies and Measures	Main Contents	Targeted GHG	Type of Policy	Status of Implementation
■ Land-Use Change and Forestry Sectors				
Promotion of Urban Greening	• Promote urban greening and establish green belts in rural areas • Spread the Green Movement to urban communities	CO_2	Regulatory Voluntary Agreement Information	Implemented
■ Waste Sector : Minimization and Recycling of Waste				
Waste Minimization	• Provide guideline for reducing waste (at production stage) in plants, controlling waste generated from packing (at distribution stage), and minimizing waste generation at consumption stage	CH_4	Regulatory Financial Support Education	Implemented
Waste Recycling	• Execute Extended Producer Responsibility System, promote and support the recycling industry and maximize waste recycling to increase consumption of recycled products	CH_4	Regulatory Financial Support Education	Implemented
■ Waste Sector : Establishment of Foundation for Waste Treatment				
Municipal Waste Landfill Facilities	• Construct 71 additional landfill facilities to increase the sanitary landfill rate to 100% by 2004	CH_4	Financial Support	Implemented
Waste Incineration Facilities	• Expand waste incineration facilities to incinerate 30% of all waste by 2011	CO_2	Financial Support	Implemented
Sewage & Wastewater Treatment Facilities	• Expand sewage treatment facilities by 2005 to raise the sewage service rate to 80%	CH_4	Financial Support	Implemented
■ Other Policies and Measures				
GHG National Registry System	• Between 2002 and 2003, conduct basic research, formulate operational plans, implement test projects and systematize related tasks so that by 2004 the GHG registering computer system is fully operational	All GHGs	Research Regulatory	Adopted
Inventory DB by Industry and Technology	• Establish technology-oriented statistics system • Research & evaluate technology by sector and stage • Design and build database • Develop software and establish operational system	All GHGs	Research Information	Implemented




4. Energy

In 2000, 83% of total greenhouse gas emissions came from the energy sector (e.g. fuel consumption and fugitive emissions). Hence, recognizing that the reduction of greenhouse gas emissions in the energy sector is of the utmost importance for devising countermeasures for the UNFCCC, profound and diverse policies and measures are being developed and promoted. In the energy sector, for instance, policies are being devised for energy supply & demand, buildings and transportation fuel.

A. Energy Demand

Collaborative energy conservation and improvement in energy efficiency have been selected as the two major promotional strategies in curving energy demand, forming the foundation for various policies.

■ 3-Year Plan for Energy Audit

A total of 10,387 cases of energy audits were performed on businesses (10,010 cases) and buildings (377 cases) between 1980 and 2001. The audits have been estimated to have had the energy reduction effect of 2,448,000 TOE each year.

Currently, Korea is implementing a 3-year Plan for Energy Audit (2002 ~ 2004) to inspect a total of 2,096 businesses and buildings that consume over 2,000 TOE a year. Expansion of the energy audit program is being promoted each year. Furthermore, close audits are being performed on 1,052 businesses that consume over 5,000 TOE and basic audits are being performed on 350 small and medium businesses that consume less than 2,000 TOE each year.

To implement the required improvements indicated by the energy audit, companies being audited will be provided with low-interest loans from a fund named the Fund for the Rational Use of Energy. For large companies, the loan is provided only when facility improvements are completed. However, if a large company is selected more than twice as an excellent energy conserving company or has

〈Table 4-4〉 3-Year Plan for Energy Audit

(Unit: Sites)

Classification		2002	2003	2004	Total
Close Audit (Charged)	Public Audit	90	130	170	390
	ESCO Audit	50	80	110	240
Basic Audit (Free)		380	430	479	1,289
Total		520	640	759	1,919

Source: Inter-Ministerial Committee on UNFCCC (2002)

concluded the Voluntary Agreement, benefits may include support for the installment of new energy-efficient facilities or expansion of existing facilities.

■ Expansion of Voluntary Agreement

The Voluntary Agreement (VA) was adopted in 1998 with 15 companies who joined the pilot VA program in the first year. By 2001, the number of participants entering into the agreement (duration of agreement: 5 years) with the government to reduce energy consumption and greenhouse gases increased to 374 companies. The VA participants in 2000 used 51,526,000 TOE annually, which is 53.2% of total energy consumption.

Korea plans to continuously increase the number of participants in the VA program. Support provided to participants will be further expanded and strengthened from current incentives such as financial assistance from the Fund for Rational Use of Energy, relief of restrictions on fuel use, and discounts on audit expenses to induce voluntary greenhouse gas reduction efforts. About 660 companies, accounting for 75% of all target companies, are expected to join the agreement by the end of 2003.

Furthermore, based on the outcome of research conducted on parties to the agreement, goals and duration of the agreement and incentives, the government plans to expand the VA program to 1,300 companies each consuming over 2,000 TOE per year from the second agreement period beginning in 2004.

■ Energy Service Companies (ESCO)

The Korean Energy Service Companies (ESCO) project started with three registered companies in 1992. The number of registered companies increased to 159 by 2001. Recently, stepping away from their initial implementation stage focussing on high efficiency lighting, the major operations of the companies have been expanded in scope to high quality businesses such as process improvement, cooling and heating facilities, waste heat utilization and cogeneration.

〈Table 4-5〉 Results of Voluntary Agreement

Classification	1998	1999	2000	2001	Total
No. of Businesses	15	52	145	162	374

Source: Korea Energy Management Corporation (2003)

〈Table 4-6〉 Status of ESCO Registrations

Classification	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Total
No. of Registered Companies	4	1	2	-1	3	7	11	27	48	57	159

Source: Korea Energy Management Corporation (2003)

〈Table 4-7〉 Status of Financial Support for ESCO

(Unit: 100 million won, withdrawal standard)

Classification	1993~1998	1999	2000	2001	Total
Cases	197	244	519	548	1,508
Loan	480	648	856	751	2,735

Source: Korea Energy Management Corporation (2003)

Korea is fostering ESCO as UNFCCC-specialized companies to tackle mid- to long-term UNFCCC-related issues. The Korean government provides low interest loan investment and the level of investments has steadily increased. There are various forms of financial support for ESCO such as the working capital loan for small and medium-sized ESCOs as well as credit loans and factoring program to lighten the debt burden of ESCO. In 2001, the financial support for ESCO reached 273.5 billion won.

■ High Efficient Equipment Certification Program

Since December 1996, Korea has been implementing the High Efficient Equipment Certification Program, which is an efficiency assurance system. This program certifies products that satisfies certain energy efficiency standards in order to encourage more widespread use of high efficiency energy equipment & supplies, such as the high efficiency induction motor.

Between 1996 and 2001, 22 subject items of high efficiency equipment were certified, and 135 companies and 759 models in total were certified under this program. Financial support and tax benefits are provided for products that have been certified as high efficiency equipment. Products are also conferred the right to use an "e" mark to certify the validity of the high efficiency equipment.

To further induce the reduction of energy consumption and greenhouse gas emissions, the government is planning to expand items qualified for certification from 22 in 2001 to 31 by 2004 and 41 by 2009. Meanwhile, an expanded rebate program will be applied to all high efficiency equipment items, in which financial support and tax benefits will be granted to energy efficient companies, and regulations mandating the use of high efficiency equipment will be expanded to cover construction standards to attain improved energy efficiency. In addition, the overall proliferation of high efficiency equipment will be expanded by first encouraging public institutions to purchase and install energy efficient equipment.

■ Energy Efficiency Standards & Labeling Program

Since 1992, efficiency standards (grades 1 ~ 5) and labels indicating the level of energy efficiency have been marked on products to encourage consumers to purchase high efficiency products that reduce energy consumption as well as greenhouse gases. Initially, the program was implemented on 5 items including refrigerators and automobiles in 1992. By 2001, 5,294 models of 11 items were clas-

〈Table 4-8〉 Status and Expansion Plan for Subject Items of High Efficient Equipment Certification Program

Classification	2000	2001	2002	2003	2004	2005~2009
Expansion Items	5	3	1	5	3	10
Total Subject Items	19	22	23	28	31	41

Source: Korea Energy Management Corporation (2003)

sified and registered, among which 3,849 models were evaluated as high efficiency products, registered as grade 1 and grade 2, and occupied 73% of the total number of models.

The government plans to examine the potential of the distribution progress, national technology standard and energy conservation to increase 1 ~ 2 items subject to efficiency classification labeling each year. In 2002, 'kimchi' refrigerators and rice cookers were designated as subject items. In 2003, compact fluorescent lamps will be designated. Subject items will increase to a total of 20 by 2010. Furthermore, an exemplification program will be implemented for companies producing relevant items. The Minimum Energy Performance Standard, which restrains the distribution of low efficiency products and promotes the technical development of manufacturers by setting up and controlling the minimum required efficiency standard, will be continuously implemented. The products registered as grade 1 and grade 2 that occupy over 90% of the market and difficult to differentiate between grades will be converted as subject items for the Minimum Energy Performance Standard program. Currently, refrigerators, air-conditioners and domestic gas boilers are included as subject items of the Minimum Energy Performance Standard.

B. Energy Supply

Various policies are being promoted for the energy supply sector through the establishment of renewable energy and cleaner energy distribution as promotional strategies to reduce greenhouse gas.

■ Formation of a Market Demand for Renewable Energy & Improvement in Its Economics

To foster the renewable energy industry, raising the level of confidence in renewable energy technology and a guarantee of price competitiveness compared with the current fossil fuel energy is necessary. Hence, the standard price for each power generating source should be announced for electricity generated at renewable energy facilities based on the amended Promotion Act for New & Renewable Energy Development, Utilization & Dissemination. The economic benefits as compared to the price of electricity are expected to enhance the competitiveness of using renewable energy as the source of generating power and promote the development of renewable energy businesses.

Korea is forming a market base to efficiently distribute renewable energy technology which is focusing its development on Photovoltaic (PV), wind power and fuel cell. Through the amendment of the Promotion Act for New & Renewable Energy Development, Utilization & Dissemination in February 2002 and Energy Conservation Guideline for Public Institutions in April 2002, public institutions including government institutions, local authorities and government invested companies were first targets to mandatorily install renewable energy facilities. Furthermore, the New & Renew-able Energy Equipment Certification Program Promotion will be developed and implemented to increase reliability and promote the spread of renewable energy facilities.

Meanwhile, the Performance Evaluation Center for New & Renewable Energy is being designated and operated to implement the standardization of each technology and performance tests of developed technology. To improve the durability and reliability of products and to secure engineering technology, a simulation research complex has been established and is being operated. The complex conducts simulation research to verify the economic feasibility and reliability of the production of such energy.

To develop and distribute renewable energy, the Korean government promotes projects that reflect the characteristics of each specific region. For example, plans are underway to construct a Wind Farm (500 MW) by 2010. To develop and distribute energy derived from the ocean, the construction of a 720 MW tidal power plant is expected to be completed by 2011. Furthermore, the potential construction of a tidal current power plant on the southern coast and wave-force power plants on the eastern coast are being examined. Photovoltaic generators (1300 MW) and landfill gas generators (105 MW) are also expected to be built by 2011.

■ Expansion of Integrated Energy Supply Project

It has been evaluated that the integrated energy businesses that supply heat and/or electricity for heating, hot water, and air conditioning have a significant impact on energy conservation and environmental improvement. Service areas are being expanded through the designation of supply location, tax benefits, administrative and loan supports, etc.[12] Meanwhile, as a measure to expand integrated energy supply, the energy generated from waste incineration facilities is being used as a source for heat. Furthermore, the number of businesses using landfill gas and the Community Energy Supply (CES) are being expanded.

■ Stable Supply of Natural Gas

Korea is endeavoring to increase the stable supply of natural gas, a source of cleaner energy with low greenhouse gas emission, and expand the supply infrastructure such as nationwide pipelines and the construction of LNG terminals. The consumption of natural gas in Korea increased by 18.2% annually between 1987 and 2000. The long-term import source which was limited to Asia such as Indonesia has been extended to the Middle East such as the State of Qatar and Oman to strengthen the stable supply of natural gas by 2010. A long-term supply contract for 16.98 million tons will be entered into in order to supply the demand for 17.8 million tons of natural gas by 2002 ~ 2004. Additional demand will be satisfied through mid-and short-term contracts.

Meanwhile, to establish a stable supply infrastructure, natural gas supply is being increased through continuous expansion of supply facilities

12) By the end of 2001, the Korean Integrated Energy business achieved a 8.9% supply rate of total households.

such as LNG pipelines and storage tanks. The nationwide pipeline business for natural gas was completed by the end of 2002 with the operational length of the pipeline network extending 2,442 km. Furthermore, storage capacity will be expanded to 4.46 billion liters with 35 tanks. Approximately 271.5 billion won will be invested between 2001 and 2004 to expand the stable supply of natural gas. As a result, the natural gas supply rate is expected to increase gradually from 58.7% in 2000 to 67.2% in 2005 and 73.0% in 2010.

■ Stable Supply Level of Nuclear Energy

To satisfy the sharply increasing demand for electricity and to suppress carbon dioxide emissions, continuous promotion for non-greenhouse gas emitting nuclear power generation will be implemented. The occupancy of nuclear power will be maintained in the long-term at an adequate level of the total power generated. It is forecasted that the adequate supply of nuclear power will greatly contribute to the reduction of the greenhouse gas emissions in Korea.

The domestic nuclear power is the largest electricity supply source with the facility capacity of 13,720,000 kw, 27.0% of the total power generated in 2001. The generated quantity was 112.1 billion kwh, 39.3% of the total power generation. Meanwhile, by 2008, radioactive waste treatment facilities will be constructed to transport and dispose the waste currently stored within the nuclear energy generation site. Repair and maintenance as well as safety evaluations will be conducted on all nuclear facilities that have reached the end of its projected lifespan to continually promote the use of nuclear energy. Technological development will also be implemented to increase the output from nuclear power generation.

■ Promotion of Landfill Gas (LFG) Projects

As of 2002, 242 landfill facilities, or 1400 sites when completed or closed landfills are included, handling municipal waste were being operated in Korea. Of the total, 31 operating sites with over one million tons of landfill capacity were selected as targets for the landfill gas utilization. The amount of organic waste in the waste brought to the landfill sites are high in Korea, hence, the generation of methane gas used for energy source is known to be higher than that of developed countries.[13] Therefore, landfill gas utilization, coupled with the development of renewable fuel, will greatly contribute to the nationwide reduction of greenhouse gas emissions.

The current LFG utilization in progress includes the world's largest metropolitan landfill site and some others with the capacity over one million m^3 which are controlled by the local government. The utilization to process landfill gas into fuel and to

〈Table 4-9〉 Status of Landfills Operated in Korea (2002)

Classification	Total	Capacity (1,000 tons)				
		15,000 이상	5,000~15,000	3,000~5,000	1,000~3,000	Under 1,000
No. of Sites	242	1	4	8	18	211

Source: Ministry of Environment (2002)

13) The ratio of methane in landfill gas is generally predicted as 50% (default value) by IPCC.

use it as an energy source is being promoted. The construction of a power plant (6.5 MW) for utilizing LFG generated at the Metropolitan Landfill Site was completed in November 2001. The next step is to construct a 50 MW power plant by 2004.

C. Buildings

■ Mandatory Standards for Building Insulation & Energy-Efficient Designs

Korea has revised the regulations on Equipment Standards for Buildings. Beginning June 2001, outer walls, roofs, and flooring of new buildings must meet the revised insulation standard requirements which is 20% higher. Furthermore, measures to actively implement the greenhouse gas emissions reduction policy by minimizing energy consumption by buildings through the expansion of mandatory application of new high efficiency equipment for new constructions will be promoted. In addition, for the efficient implementation of the Design Standards for Building Energy Efficiency, expositions are being held and technology administration guides are being issued.

Meanwhile, 8 types of large high-energy consuming buildings, including offices and hospitals, have been mandated to apply a separate Design Standard for Energy Efficiency since June 2001. For these buildings to be approved, efforts must be made to expand the use of high efficiency energy products such as high efficiency gas boilers and refrigerators. As a second step, improvements in the Standards for Building Energy Efficiency and insulation are being promoted to upgrade current prescriptive standard to a performance based standard.

■ Energy Efficiency Labeling Program for Buildings

To increase energy efficiency in the building sector, newly built or repairing multi-dwelling units with more than 18 households will be classified into grades 1 ~ 3 depending on the use of energy-conserving facilities and equipment throughout the life cycle of the construction project. Buildings that are above a certain performance standard will be given the Certificate of Building Energy Efficiency and a loan for the construction at a lower interest rate.

The Korean government will annually expand the energy efficiency labeling program by targeting detached houses in 2003 and business buildings in 2004 ~ 2010. The expanded implementation of this program is projected to play a significant role in the inducement of voluntary reduction of greenhouse gas emissions through fundamental energy conservation by the building sector which consumes about 23% of the total national energy.

■ Green Building Certification Program

The Green Building Certification Program evaluates the elements affecting the environment throughout the life cycle of the building construction process (production of material, design, construction, maintenance and dismantling of buildings) with the goal to improve the environmental

performance of the buildings and reduce greenhouse gas emissions.

Between October 1999 and December 2000, the Ministry of Environment and Ministry of Construction and Transportation implemented the Feasibility Certification Program. In 2001, integrated implementation guidelines for the Green Building Certification Program was provided. In January 2002, promotions targeting multi-dwelling units were implemented. Certification audits will be targeted for existing buildings, but, if the construction contractor desires to be audited from the beginning stage of design, a preliminary certification will be endowed. The terms of validity for the certification is 5 years. Extension may be requested for additional 5 years, but, after 10 years, the regulation requires renewal.

The Korean government will expand, in phases, the subject of certification, which is currently limited to multi-dwelling units, to housing & commercial complexes, business (public, private buildings), commerce (schools, hospitals, etc.), and remodeling buildings. Furthermore, the Life Cycle Assessment (LCA) for material production, design, construction, maintenance and destruction of buildings will be implemented to minimize environmental impact. In addition, a scheme to evaluate greenhouse gas emissions reduction in detail will be also be implemented.

D. Transportation Fuel

■ Compressed Natural Gas (CNG) Buses

In 1999, an amendment was made to the Air Quality Preservation Act to establish a legal basis to convert urban buses to natural gas buses. In December 2002, an amendment was made to the same Act to enforce the use of no or low pollution vehicles and formed a systematic basis to expand natural gas buses. The supply of 5,000 buses by 2003 is planned. By 2007, approximately 20,000 urban buses will be in service nationwide

To promote the substitution and supply of natural gas buses, financial support for the purchase of buses, interest reduction on loans for LPG station installation expenses and tax benefits will be provided. Furthermore, to achieve the support necessary in constructing the infrastructure to supply natural gas, amendments was made to the Construction Law, Urban Planning Law, High Pressure Gas Safety Control Law, and other relevant laws. As a result of the above efforts, 2,746 CNG buses were in service nationwide as of December 2002 with 89 CNG stations in service.

■ Compact Cars

For sound distribution of compact cars, the purchase or utilization of compact cars will lead to such benefits as reduced or waived vehicle tax, discounted expressway tolls & public parking, and other discounts in the use of traffic facilities. As a result of the compact car expansion policy, 713,000 compact cars, or 8.0% of the total, were distributed by the end of 2001. Compact car distribution rate will continue to increase.

■ Development of Diesel Cars

Diesel cars emit approximately 20% less greenhouse gases compared with gasoline-run cars. Hence, to promote the development and distribution of diesel cars, technological development support related to diesel cars are being provided. Through the above project, reduction in greenhouse gas emissions will be achieved to meet the enforcements of the EU Automobile Agreement. Furthermore, diesel engine filters and catalyst technology development will be promoted as part of the technology development business for vehicles of the future.

5. Transportation

The efficient management of the national transportation system and traffic demand is part of the major promotional strategy in the transportation sector. It also includes the establishment of a comprehensive logistics information network and the standardization of logistics equipment. Hence, relevant policies and measure are being implemented.

A. Efficient Management of National Transportation System & Traffic Demand

■ Promotion of Efficient Transport Mode Sharing

Improvement will be made in the transport mode sharing structure by reasonably increasing modal split of railways and marine transportations that have large transportation capacity and relatively low greenhouse gas emissions to ultimately establish an energy-saving national transportation system.

Modal split for domestic passengers and domestic freight on railways will increase from 7.6% and 10.5%, respectively, in 1997 to 14.2% in 2004. On the other hand, the modal split for domestic passengers and domestic freight on roads are expected to fall from 88.2% and 56.6% in 1997 to 81.3% and 49.7% in 2004, respectively.

To improve the structure of the modal split, the Transportation System Efficiency Act was enacted in February 1999. The National Intermodal Transportation Plan, renewed every 20 years and the 1st mid-term transportation facility investment plan, an action plan renewed every 5 years, were established in December 1999 and March 2001, respectively, and have been implemented.

■ Reduction of Traffic Congestion Areas

A plan will be implemented to alleviate the traffic congestion phenomenon of national roads and reduce driving time of congested and bumper-to-bumper areas by constructing detours, for example, to reduce the greenhouse gas emissions from automobiles. To implement the plan which will alleviate traffic congestion, the rate of national roads with more than 4 lanes will be increased from 33% in 2001 to 50% in 2010. Furthermore, for areas that show severe traffic congestion, 449 km of detour roads substituting for national roads will be constructed by 2006. Improvement will also be made to the 864 bottle-neck areas such as intersections and underground driveways.

■ Expansion of Public Transportation Service

The construction of low energy-consuming and low greenhouse gas-emitting urban railways and light rail transits will be expanded. In 2001, 401.4 km of urban railway lines, a total of 12 lines, in Seoul, Busan, Daegu and Incheon were in operation. In 5 cities, 144 km of 7 additional lines have been constructed to continuously expand the met-

〈Table 4-10〉 Modal Split by Transport Modes for Domestic Trips

(Unit: %)

Classification	Domestic Passengers				Domestic Freight			
Mode of Transportation	Road	Rail	Air	Sea	Road	Rail	Air	Sea
1997	88.2	7.6	4.0	0.2	56.6	10.5	0.1	32.8
2004	81.3	14.2	4.3	0.2	49.7	14.2	0.3	35.8

Source: Inter-Ministerial Committee on UNFCCC (2002)

ropolitan railroad network. Ad to subways in large cities, 422.74 km will be extended by 2004 and 545.4 km will be extended by 2007 to increase the modal split of metropolitan railway network.

For efficient transportation between large cities and their satellite cities, low-cost lightweight electric railway construction is actively being promoted. The construction of light rail transit that connects to the outer boundaries of the city is being promoted as a private participation project. Furthermore, to increase the use of public buses, 510.4 km in 127 sections has been designated and operated as exclusive bus lanes in 8 cities and provinces by the end of 2001.

■ Traffic Demand Management

To curb excessive use of automobiles that cause traffic congestion and to promote the use of public transportation, a reinforcement policy for traffic demand management is being implemented. As a measure to achieve the goal, the Traffic Demand Management Policy was established in January 2001 and is being actively implemented. Automobile numbering program, commuting bus operation, variation in commuting hours and providing incentives to companies implementing Traffic Demand Management such as a reduction in traffic congestion charge are being conducted. Furthermore, chronic traffic congestion areas are being designated as a traffic congestion special management zone to improve one-way traffic, signal systems and parking lot use, for example, and to introduce and implement downtown traffic demand management policy.

■ Regulation on Idle Running Vehicles & Restrictions on Car Use

Through the amendment of the Air Quality Preservation Act in December 2002, regulation are been applied in areas with frequent occurrences of car idling for an extended period such as in terminals, garages and parking lots. According to the circumstances that reflect the specific area, policies that limit unnecessary idling are being enforced through local authorities. Enactment of the ordinance for each local authorities were completed before July 2003 with currently implemented policies that limit unnecessary idling of automobiles. Furthermore, to induce voluntary participation of the drivers, promotional advertisements to enforce regulation on idling are being implemented.

B. Establishment of a Comprehensive Logistics Information Network and Standardization of Logistics Equipment

■ Establishment of a Comprehensive Logistics Information Network

A comprehensive logistics information network is being established as a bulk treatment for handling logistics through informatization of logistics bases such as airports and inland container depots, and mutually connecting the operation with customs clearance networks. Between 2002 ~ 2005, nationwide informatization of inland container depots for 5 major areas will be implemented. Furthermore, as a measure to keep abreast the expansion of e-commerce, the third step of the basic plan for the comprehensive logistics information network to establish a mutual link with the government and relative logistics network has been established and implemented (2002 ~ 2003).

■ Promotion of Logistics Standardization

To achieve standardization at the government level, mechanization, automation, and consistent transportation for logistics activity, and compatibility and liaison between logistics facilities and equipment are being implemented. Furthermore, system improvements are being made through the estab-

lishment of standardized specifications which will ensure compatibility between logistics related facilities and equipment. To increase the standard pallet load efficiency, expansion is being made to the cargo space of medium-sized trailers. A Korean, Chinese, Japanese pallet pool will be established in the future to strengthen international collaboration on logistics standardization specification. Furthermore, by establishing a promotional plan for nationwide logistics standardization policy, government institutions will set common goals to build a role-sharing system.

6. Agriculture and Livestock

The effort to reduce greenhouse gases in the agriculture and livestock sector is being made through the improvement in farming and animal husbandry methods. The policy for the agriculture sector is classified into the reduction of methane emissions from irrigated rice paddies and nitrous oxide from uplands. As to the livestock sector, reduction of greenhouse gases is made through the improvement of enteric fermentation of ruminant and livestock manure treatment facilities.

A. Reduction of Methane from Irrigated Rice Paddies

Policy is being implemented to reduce the emission of methane, a greenhouse gas normally generated in irrigated rice paddies, by developing and distributing the measurement and reduction technology for methane. Methane emission is also being reduced through the development of rice growing patterns and water management as well as varietal improvements. Continuous promotion is being made for labor-saving cultivating methods such as direct seeding on dry paddy (known to reduce 61.4% of methane emissions compared with transplantation of rice seedlings) and intermittent irrigation (known to reduce 26.2% of methane emission compared with flooding).

Meanwhile, development of an integrated model for methane mitigation and its propagation project is being implemented. The project is intended to develop cropping technologies that will reduce the emission of methane according to the method of using arable lands in each territory and the method of cultivation. Furthermore, continuous promotion and education is being conducted targeting farmers and related institutions to share and distribute the results of research and technological developments. In the winter farming education courses, labor-saving cultivation methods, such as direct seeding on dry paddy and intermittent irrigation, will be actively encouraged among farmers for the promotional application of farming technology which will allow the reduction of methane emission from rice paddies. The goal is to reduce the emission of methane in rice paddies to 90% of 2000 levels by 2010 through the improvements in rice plant cropping patterns and irrigation methods.

B. Reduction of Nitrous Oxide from Uplands

The increase in the cultivation of high-profit crops and vegetables has also increased the emissions of nitrous oxide in upland soils. Hence, reduction efforts for nitrous oxide are being made through the development of technology to measure and reduce emission of nitrous oxide.

A basic measuring system has been successfully established, in addition to a nationwide field measurement, to calculate the emission of nitrous oxide beginning in 2002. Furthermore, guidance in farming methods are provided to induce the reduction of nitrous oxide by decreasing the use of nitrogenous fertilizers. To foster environmentally friendly agriculture, soil is inspected through the integrated nutrient management device. Soil inspection to

ensure that the adequate allowance of nutrients are in the earth at the right time is being strongly recommended, along with providing guidance to farmers regarding the appropriate use of fertilizers.

As a measure to accurately evaluate nitrous oxide emissions in arable land, close examination of nitrous oxide emission in the uplands and the development of nitrous oxide reduction technology have been promoted (2000 ~ 2004). The set target is to reduce the nitrous oxide emitted in 2000 by 95% in 2010.

C. Improvement in Enteric Fermentation of Ruminant Livestock

Methane is mainly emitted from enteric fermentation of ruminant in cattle's digestive process. Ruminants, such as Korean native cattle and dairy cattle, are major source of emission. Livestock policies such as livestock improvement, expansion in the spread of high quality forage and adding ruminant stomach fermentation control medicine to livestock diet were implemented to reduce methane. Through such livestock policies, the 771,000 TC of methane in 2000 would be reduced to 606,000 TC in 2010.

■ Livestock Improvement Program

The number of livestock for each livestock category, including cattle, swine and poultry, will be adjusted to contain excessive generation of methane from over-breeding. To meet the increasing demand for livestock products, improvements should be made through breeding to increase productivity while reducing methane emission from enteric fermentation of ruminant. The maintenance of adequate livestock heads and the improvement of livestock productivity are expected to reduce methane emissions by 1.2% each year. Furthermore, relevant financial support and supervising & control duties are being implemented.

■ Expanding the Spread of High Quality Forage

By providing ruminants with high quality forage rather than rice straw or wild grass, emission of methane will decrease. In addition, the relative nutrients in the high quality forage is superior to those of rice straw and wild grass, hence, productivity of livestock will increase. Currently, programs for the building of feasibility units, manufacturing of related machines & equipment, and construction of forage production facilities are being implemented to expand the production base for high quality forage.

■ Adding Fermentation Stabilizer in Ruminant

Research on the effect of reducing methane emissions through mixture of variation in types of raw forage and its processing methods, and adding fermentation stabilizers and microorganism repressors to improve the fermentation condition of ruminants is being conducted (2002 ~ 2004).

D. Improvement in Livestock Manure Treatment Facilities

Today, most large breeding farmhouses in Korea have installed and are operating disposal facilities for livestock manure. As of 2001, 96% of the facility farmhouses (61,000 units) had installed disposal facilities, of which 92% retains compost and liquid manure resource facility. Farms without their own facilities use the services of processing plant for livestock wastewater. Furthermore, the government is continuously implementing the livestock manure resource promotion policy. The government has set aside 157.8 billion won to improve operation methods and facility management of users between 2001 ~ 2004. Investments will also be allocated to projects for manure liquefaction. Furthermore, the disposal facility model will be expanded and applied nationwide, and renewable energy utilizing facility program will be expanded and promoted to reduce methane emission and to provide guidance to users.

7. Land-Use Change and Forestry

Korea enforces a nationwide sustainable forest management by legislation through the Forest Basic Law established in 2001. Furthermore, the National Forest Program is being promoted to implement a sustainable forest management. Policies to increase removals and reduce emissions will be carried out through the Forest Tending Projects, forest pest insect and disease management activities, forest fire management activities, mandatory replantation of harvested area, and promotion of urban greening.

A. Promotion of Forest Tending Project

The central and local governments as well as private organizations have exerted continuous efforts into the Forest Tending Project to maintain the health of forests which resulted in maintaining or increasing carbon dioxide sequestration. From 1998 to 2001, 646.9 billion won was invested to promote the Forest Tending Project in a total forest area of 1,024,000 ha. The projects not only maintain or increase carbon dioxide sequestration, but also improve water conservation as well as the habitat of wildlife. To increase the sequestration of carbon dioxide in the forest, a 10-year Forest Tending Project was established. Furthermore, by 2007, the Forest Tending Project will be implemented on 2,800,000 ha.

B. Control of Forest Pest Insects and Diseases

Early detection and timely control of forest pest insects will aid in the preservation of forest resources and a healthy forest ecosystem which will maintain or increase carbon sequestration. In 2001, 5% of the total forest area (337,000 ha) suffered from various pathogens, pests and insects. Pests affecting pines were especially high accounting for more than 40% of the total tree pestilence. Over the past five years, 75% of the pest outbreak area have been controlled. The adoption of a Forest Pest Mon-

〈Table 4-11〉 Results of Forest Tending Project (1997~2001)

(Unit: ha)

Classification	Average	1997	1998	1999	2000	2001
Thinning	44,714	35,985	37,276	54,177	51,740	44,392
Rearing Natural Forest	40,171	24,312	27,296	52,588	52,055	44,605

Source: Korea Forest Service, *Statistical Yearbook of Forestry*, Various Volumes

itoring System will strengthen early detection and timely control of pests and decrease the exposed area. Special attention will be given to pest control of pine forests.

C. Enforcement of Forest Fire Management System

Protecting people, property, forest ecosystem and forest resources by preventing forest fires also averts massive emissions of greenhouse gases and preserve valuable carbon sinks. Continuous efforts have been made toward the prevention of forest fires between 1997 and 2001. Nevertheless, an average annual of 524 forest fires have destroyed over 6,000 ha of forest land. In 2000 alone, large-scale outbreaks of forest fires consumed 25,607 ha. Most forest fires are the result of carelessness and weed burning. To realize an effective system of forest fires suppression, the number of professional fire fighters and equipment will be expanded.

D. Control Deforestation and Enforcement of Replantation of Harvested Areas

To prevent indiscreet deforestation, deforestation permit system and replacement of reforestation cost scheme were introduced to the Forestry Law. Furthermore, the Forest-Land Management Law was enacted in 2002 to establish deforestation permit standards. Reinforcement of deforestation standards is being made through the Prior Consultation System operated by the Committee on Forest-Land Management. Mandatory replantation of harvested areas is enforced by the Forest Law and a support program to promote the afforestation of idle land is being operated. Economical incentives, such as financial support or loan benefits, are provided to those who convert idle land into forests.

E. Promotion of Urban Greening

To improve the quality of life in cities, tree planting in urban areas is being actively pursued by citizens and local governments. After the administrative integration of the inner city and suburban areas in 1995, the administrative boundaries of urban areas have been greatly expanded. Hence, urban forests have increased 4.5 times from 1993 to 2000. Promotion of urban greening creates new and additional carbon sinks.

8. Waste

Policies to reduce greenhouse gas emissions in the waste sector may be differentiated into two strategies. One is the minimization of waste and maximization of recycling programs to proactively prevent the greenhouse gas emitted from the generation and decomposition of waste. The other is the expansion of environmental facilities for treatment to reduce greenhouse gas emissions from the unavoidably generated waste.

〈Table 4-12〉 Forest Fires and Damage (1997~2001)

Classification	Cases	Area (ha)	Damaged Growing Stock (m^3)
Average	524	6,077	299,668
1997	524	2,330	40,815
1998	265	1,014	44,092
1999	315	473	6,377
2000	729	25,607	1,373,302
2001	785	963	33,753

Source: Korea Forest Service, *Statistical Yearbook of Forestry*, Various Volumes

A. Waste Minimization

To mitigate the primary generation of waste, a major source of methane emission, policies to minimize waste are being implemented throughout the life cycle of waste - generation, distribution and consumption. To minimize waste at its generation stage, Guideline for Waste Reduction at Works, indicating the responsibilities of the waste producers, is implemented. By the end of 2001, the businesses obliged to follow the guideline numbered 782 in fourteen industries generating more than 200 tons of hazardous waste a year.

At the distribution stage, policies to improve the packaging materials so that it may be recycled or reused are being implemented to reduce the waste quantity of packaging materials, a major target of the government. Furthermore, at the final consumption stage, allocation of waste treatment expenses to the waste producers (volume-based waste fee system), efficient management of food waste and food waste used for resources are major policies for minimizing waste.

B. Waste Recycling

The Extended Producer Responsibility System began implementation in 2003 to promote the reuse and recycling of waste at the manufacturing stage. It requires the manufacturers to be responsible for the waste generated during the production process. Furthermore, for manufactures of resource waste such as paper, glass containers, and iron & steel, businesses with a certain production scale and higher and designated businesses devoted to resource recycling, a certain quota for the use of waste resource as material must be met.

In addition, the government, recognizing the weak domestic recycling industry, provided loan support of 223 billion won between 1994 and 2000 for the installation of recycling facilities and development technology. Beginning in 2001, 60 billion won was allocated as the recycle industry fund. Furthermore, to expand the consumption of recycled products, public institutions must be the first to purchase products manufactured from recycled material.

C. Establishment of Foundation for Waste Treatment

Waste minimization and recycling policy has been implemented. Nevertheless, a certain amount of waste is unavoidably generated. As a measure, Korea has expanded the installation of Basic Environment Facilities to minimize greenhouse gas emissions through sound and adequate waste treatment of wastes that have been unavoidably generated.

■ Municipal Waste Landfill Facilities

At the end of 1998, sanitary landfill rate was 84%. To increase the rate to 100% by 2004, 71 additional landfill facilities are being constructed. Construction has been completed for 46 sites

〈Table 4-13〉 Status of Municipal Waste Landfill Facilities (2001)

(Unit: 1,000 m³)

Sites	Scale		Previous Landfill Volume	Landfill Volume in 2001	Remaining Volume
	Area(1,000㎡)	Capacity			
242	28,255	361,648	126,950	14,248	234,698

Source: Ministry of Environment (2002)

〈Table 4-14〉 Status of Waste Incineration Facilities

Classification	~ 1998	1999	2000	2001	2002
Sites	44	15	16	17	9

Source: Ministry of Environment (2002)

(7,831,000 m²)[14] which have been operating since 2001. Twenty five sites (2,759,000 m²) are currently being constructed. Local authorities establishing the landfills received 50% of the facility costs from the National Treasury of the central government in 1996. Since 1997, 30% of the facility cost was subsidized.

■ Waste Incineration Facilities

Korea is a small country with limited land and high population density. For this reason, it is difficult to secure sites for landfill facilities. To resolve the problem and to sanitarily treat combustible wastes, the construction of incineration facility is being expanded. By 2011, 30% of all waste generated will be treated at the incineration facilities. At the end of 2001, 27 incinerators are being operated and 8 incinerators are being constructed. The central government will provide financial support for the local authorities planning to construct such facilities.

■ Sewage & Wastewater Treatment Facilities

Reduction on greenhouse gas emissions can be achieved through systematic treatment of sewage collected from households and factories. Furthermore, the treatment contributes to water quality improvement and decreases the loading rate of the water pollution. Between 1999 and 2001, a total of 183 sewage treatment facility sites were constructed to achieve a sewerage supply rate of 72%. Expansion programs will be made to increase the number of sewage treatment facilities to 492, targeting an 80% increase in sewerage supply rate.

Furthermore, to treat the high density industrial wastewater generated from factory concentrated areas such as industrial complexes, 12 wastewater treatment facility sites were built between 1996 and

〈Table 4-15〉 Operation of Sewerage & Wastewater Treatment Facilities (2002)

Classification	Sites	Facility Capacity (1,000 m³/day)
Total	320	20,361
Sewerage Treatment Site	201	19,596
Wastewater Treatment Site	119	765

14) Include the 3rd section of works of the metropolitan landfill area (3,812,000 m²).

2001. Fifteen additional sites will be built by 2005.

9. Other Policies and Measures

A. National Registry System for Greenhouse Gases

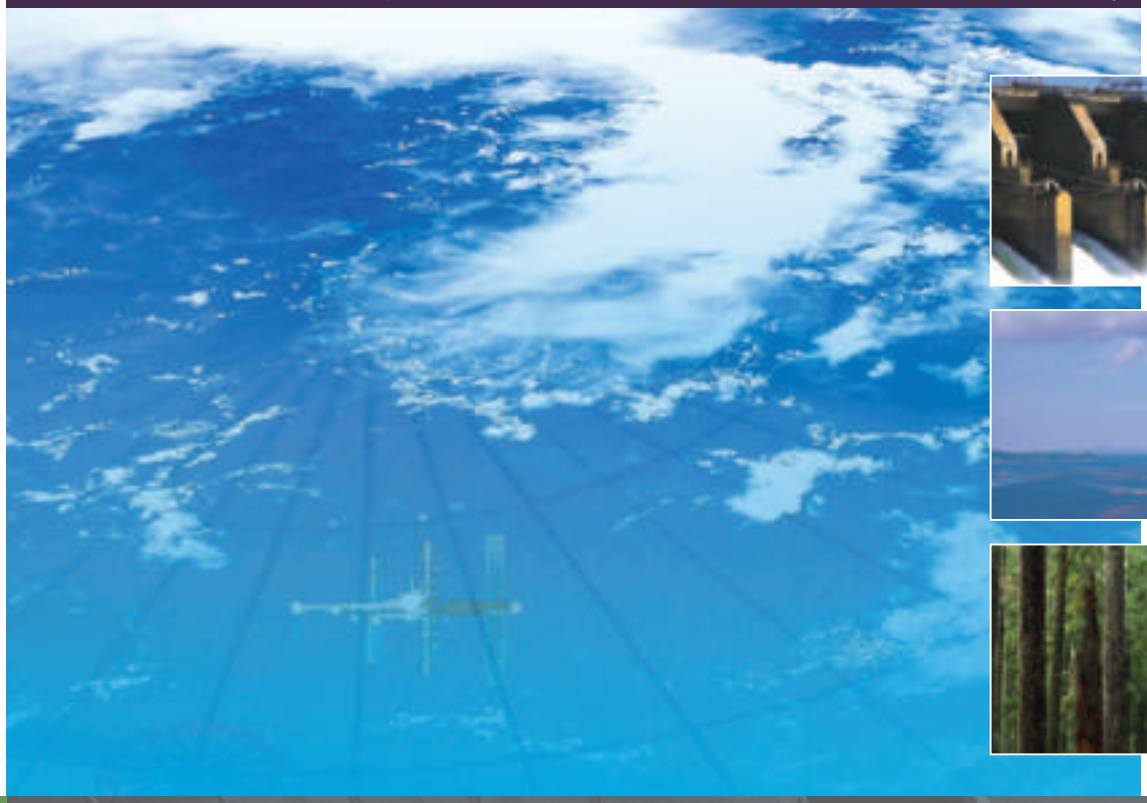
For energy conservation programs and greenhouse gas emissions reduction programs that have been promoted internationally, Korea recognized the need for an evaluation process and registry system for the actuals on reduction that conforms to the UNFCCC and international speculations. Therefore, a registry system for greenhouse gases that certifies and evaluates the greenhouse gas emissions reduction actuals was established.

In 2002, a registration guideline and operation plan was prepared and a method for calculating greenhouse gas reduction by major machineries and tools developed. Plans are underway to regulate tasks involving the establishment of a monitoring and verification system.

B. Inventory DB by Industry and Technology

To ensure the reliability of the development effects and adoption of new technology, fundamental technology information that evaluates in advance the effects of implementation of the energy policy is necessary through the securing of performance data of a technology under specific criteria and status of energy technology utilization. Korea has initiated the DB building program for energy technology. Currently, research on process evaluation has already been completed for the cement, steel, paper manufacturing and boiler industries. Furthermore, process evaluation and technology research is being made in the refined oil and petroleum sectors, and technology research and DB establishment is being made in the transportation and household sectors.

Technology research and evaluation will be implemented in stages for such industries as (textiles, non-metals, primary metals, rubber/plastics, paper and food), common equipment and tools (electric motors, lighting equipment, heat exchangers), transportation, household and commerce sectors. Furthermore, a data management software for the sectors will be developed and distributed.



Chapter 5 Projections of Greenhouse Gas Emissions

Chapter 5 Projections of Greenhouse Gas Emissions

1. Outline

This chapter comprises projections of greenhouse gas emissions between 2000 and 2020 in Korea. The policies and measures which have been already implemented and/or adopted for the reduction of greenhouse gases have been reflected in the projections.[15)]

The Korean economy is anticipated to sustain a growth rate of 4~5% during the forecast period with projected growth in the service industry and decline in the mining and manufacturing industries making it highly difficult to forecast accurate levels of greenhouse gas emissions. Therefore, emissions from alternative gases for CFCs[16)] and industrial processes and fugitive emissions are omitted in the projections due to the lack of available data.

The economic growth rate, Korea's circumstances at home and abroad, national policies, etc. were taken into account in calculating activity data forecasts by source and sink. Projections by the Korea Energy Economics Institute were used in forecasting emissions from fuel combustion which accounts for most of the greenhouse gas emissions.

15) The energy sector applied 2003 projections by the Ministry of Commerce, Industry and Energy and the Korea Energy Economics Institute; land-use change and forestry adopted projections by Korea Forest Research Institute; and the waste sector adopted projections by Environment Management Corporation.

16) HFCs (Hydrofluorocarbons), PFCs(Perfluorocarbons), SF_6(Sulphur hexafluoride).

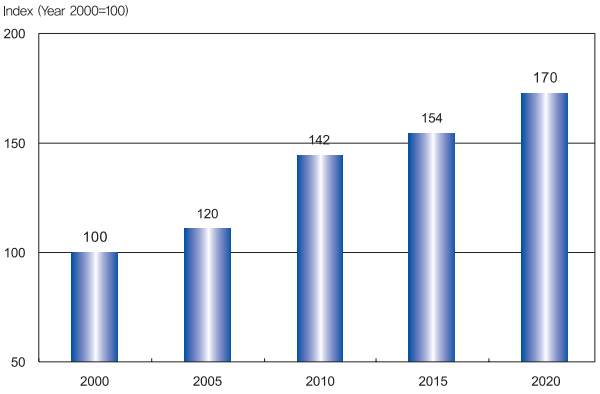
On the other hand, emissions from agriculture and waste sectors and removals from land-use change and forestry sector were calculated on the basis of previous trends and taking into account social economic changes and currently implemented or adopted policies and measures.

2. Aggregate Projections of Greenhouse Gas Emissions

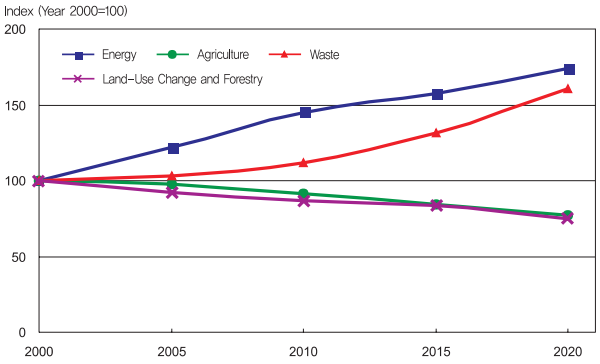
The growing trend of greenhouse gas emissions will continue if the current shift of Korea's industrial structure continue and considerable efforts to reduce emissions are not implemented. Projections indicate that Korea's greenhouse gas emissions[17] will rise by 70% above 2000 levels in 2020 (Figure 5-1). However, the carbon dioxide intensity during the forecast period is expected to gradually decrease due to improvements in demand-side energy efficiency and shift to cleaner fuels.

Greenhouse gas emissions from energy, agriculture and waste which accounted for about 90% of the total emissions of greenhouse gases is expected to increase by 2.7% annually from 2000 to 2020. During the same period, emissions from fuel combustion will increase by 2.8% annually and emissions from waste by 2.4%, whereas removals from land-use change and forestry and emissions from agriculture are projected to annually decrease by 1.4% and 1.1% annually, respectively.

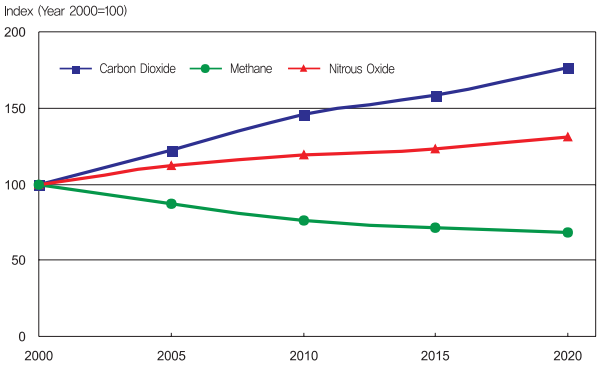
According to projections by gas, carbon dioxide, the main gas from energy related GHG, will see a relatively modest increase of 2.9% annually from 2000 and 2020 and account for 96.8% of all greenhouse gas emissions in 2020 from the 93.5% in 2000. This is largely due to the government's energy conservation efforts to comply with the UNFCCC as well as improvements in energy efficiency,



[Figure 5-1] Projected GHG Emissions Trend (2000~2020)

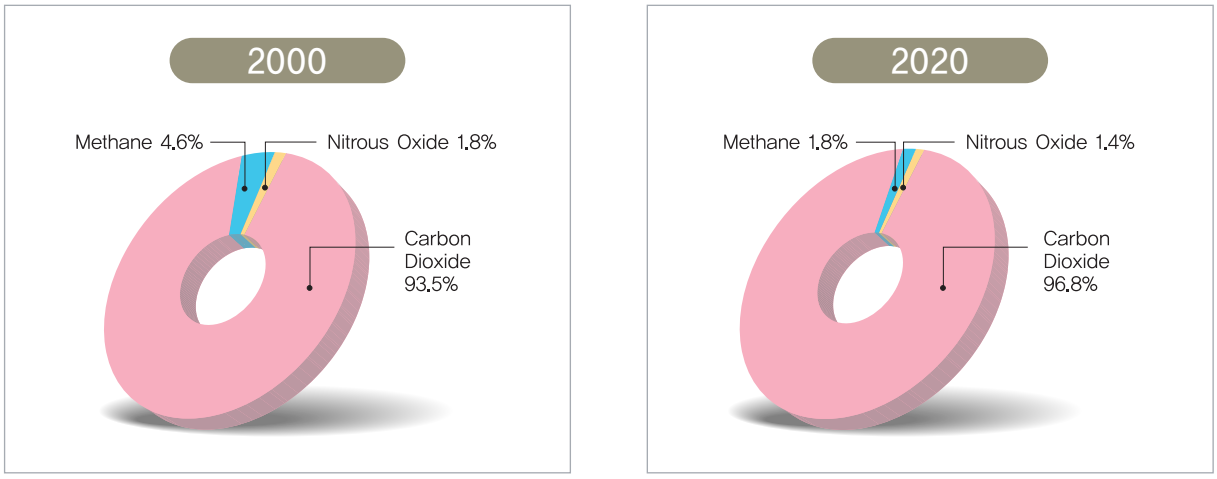


[Figure 5-2] Projected GHG Emissions and Removals by Sources/Sink (2000~2020)



[Figure 5-3] Projected Emissions by Gases (2000~2020)

17) Emissions form the fugitive sources, industrial processes and alternatives for CFCs (HFCs, PFCs, SF_6) have been excluded from the projection.



[Figure 5-4] Changes in Proportion of Emissions by Gas

increase in the consumption of low carbon energy and renewable energy and increase in waste incineration.

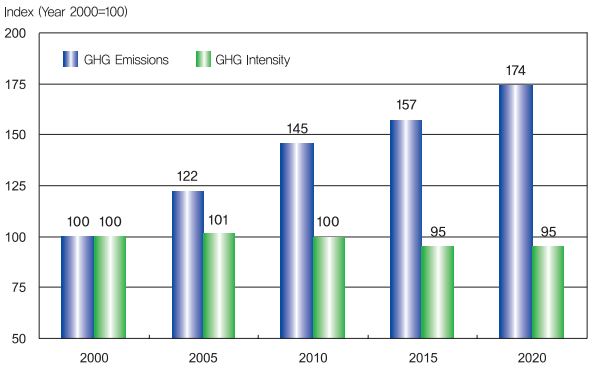
Although emissions of nitrous oxide and methane from waste are expected to increase, projections indicate emissions of nitrous oxide, which accounted for 1.8% of total greenhouse gas emissions in 2000, will decrease by 1.2% annually and account for 1.4% in 2020. Methane emissions are also expected to decrease by 1.9% annually from occupying 4.6% of total greenhouse gas emissions in 2000 to 1.8% in 2020 due to the reduction in the number of livestock and land dedicated to rice cultivation.

3. Projected Emissions and Removals

A. Energy

Greenhouse gas emissions from fossil fuel combustion is projected to increase by 3.8% annually from 2000 to 2010. After 2010, however, the average annual growth rate of emissions from fossil fuel combustion is projected to decrease to 1.8% until 2020. Greenhouse gas emissions from the energy sector are estimated to rise by 74% above 2000 level by 2020. In the long-run, however, greenhouse gas intensity (GHG/energy) is projected to decline by 5% from 2000 to 2010 (Figure 5-5).

The proportion of greenhouse gas emissions generated by the industrial sector to the total greenhouse gas emissions from energy use is projected to decrease to 31% in 2020 from a 35% in 2000 as a consequence of a slowdown of energy-intensive industries,[18] reduction of the share of bituminous coal in energy consumption and gradual decline in the growth rate of energy consumption. The transportation sector is projected to record the highest growth rate of greenhouse gas emissions among

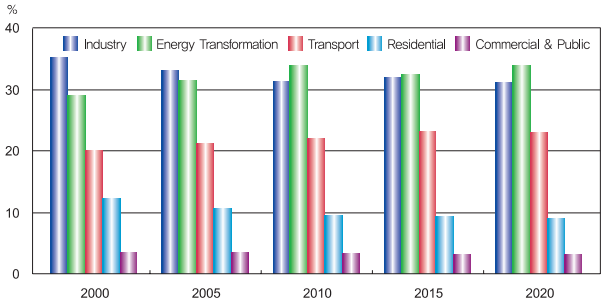


Note: Fugitive GHG emissions are excluded.

[Figure 5-5] Projections of Major GHG Indicator in Energy Sector

18) In particular, the production growth rate of pig iron and cement began to decrease after 2001.

the energy sector due to the relatively high increase in the energy demand and limited substitution possibility among energy sources. The proportion of emissions from the transportation sector to energy use is estimated to increase to 23% in 2020.



Note: Fugitive GHG emissions are excluded.

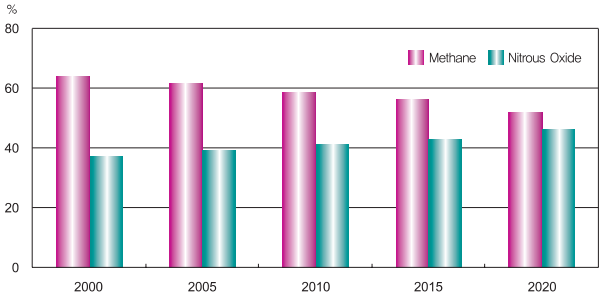
[Figure 5-6] Projected Proportion of GHG Emissions by Energy Sector

Although the growth rates of the population and number of households may be slowing down, greenhouse gas emissions from the residential sector is projected to increase largely due to the expansion of the total floor area as a consequence of the increasing income level. However, the proportion of greenhouse gas emissions from the residential sector is projected to decrease from 12% of total emissions from energy use in 2000 to 9% in 2020. The advanced industrialization and rise in income have accelerated the consumption of electricity compared to other energy sources. As a result, emissions in the energy transformation sector, which accounted for 29% in 2000, are projected to account for 34% in 2020.

Projections of greenhouse gas emissions in the energy sector, with the exception of fugitive emissions, indicate carbon dioxide to comprise 99.5% of total emissions from fuel combustion, whereas very little amounts of methane and nitrous oxide are emitted during the process of fuel combustion. Emissions of carbon dioxide are estimated to increase by 2.8% annually during the projection period and emissions of methane and nitrous oxide are projected to increase by 1.0% and 4.1% annually, respectively.

B. Agriculture

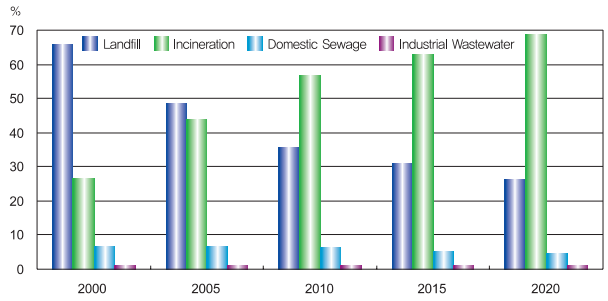
The greenhouse gases emitted from agriculture are methane and nitrous oxide. Irrigated rice fields, enteric fermentation and manure management are major sources of methane which is projected to fall by 2.0% annually from 2000 to 2020. Therefore, proportion of methane, which accounted for 63% of total greenhouse gas emissions in the agriculture, is estimated to decrease to 52% in 2020. On the other hands, emissions of nitrous oxide, which is emitted from the use of nitrogenous fertilizer and livestock manure as fertilizer for crops, are projected to only increase by 0.1% annually over the same period. Nevertheless, the proportion of nitrous oxide, which accounted for 37% of total emissions in the agricultural sector in 2000, is projected to increase to 48% by 2020.



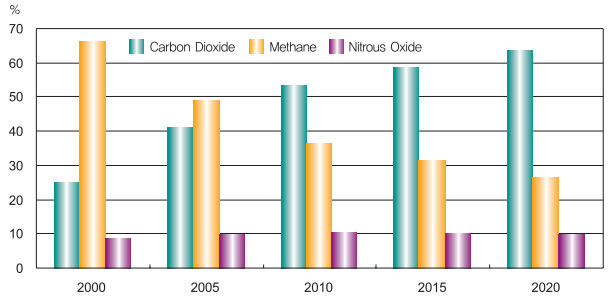
[Figure 5-7] Projected Proportion of Emissions from Agriculture by Gas

C. Waste

Greenhouse gas emissions from waste are expected to increase by 2.4% annually between 2000 and 2020. The waste management policy instituted by the Korean government, which proposes fewer landfills and more incineration, is expected to increase emissions of carbon dioxide and nitrous oxide from waste incineration. However, the growth rate by gas is expected to vary depending on the changes in waste components. Therefore, the proportion of greenhouse gases



[Figure 5-8] Projected Proportion of GHG from Waste by Activity



[Figure 5-9] Projected Proportion of Emissions from Waste by Gas

emissions from incineration is projected to continually increase, while the proportion of emissions from landfills is estimated to decrease.

Population, water consumption level, protein consumption, etc. directly affect the amount of greenhouse gas emitted from domestic sewage. However, future changes in lifestyle and mild increase in population are projected to result in a lower growth rate of methane and nitrous oxide emissions from domestic sewage.

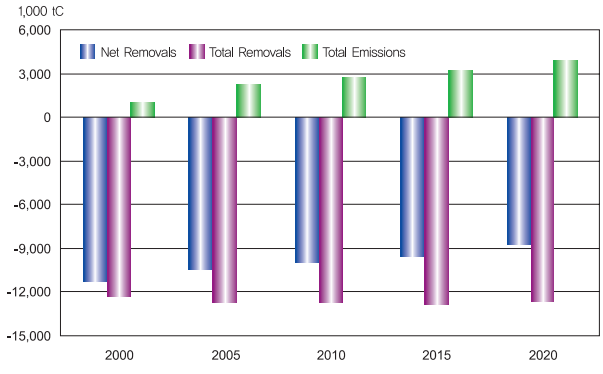
Greenhouse gas emissions from industrial wastewater, which is influenced by the amount of industrial water converted into wastewater, are also estimated to show a slow growth rate. Therefore, the proportion of greenhouse gas emissions from domestic sewage and industrial wastewater in the waste are projected to slowly decline.

Emissions of carbon dioxide from the waste sector, which accounted for 25% in 2000, are projected to increase sharply to 64% by 2020 due to the growth of the proportion of incineration in waste treatment. On the other hands, the proportion of emissions of methane, which comprised 66% in 2000, are estimated to decrease dramatically to 27% by 2020.

D. Land-Use Change and Forestry

The net removals from land-use change and forestry sector between 2000 and 2020 are estimated to fall by 1.4% annually. This projection is based on the IPCC (1996) and the forest growing stock projections indicated in the *4th Forest Basic Plan* (1998-2007) published by the Korea Forest Service. Although the level of total removals will remain almost the same in the category of changes in forest and other woody biomass stocks,[19] emissions attributed to harvests are projected to increase by 6.9% annually between 2000 and 2020.

As for forest and grassland conversion and land-use change, it is assumed that the level of emissions will remain relatively unchanged from the average level of emissions over the past five years since there has been very little change during recent years and activity forecast data is not available.



[Figure 5-10] Projected GHG Emissions and Removals from Changes in Forest and Other Woody Biomass Stocks

19) Projection covers all forest areas in Korea and carbon pools of above and below ground biomass.

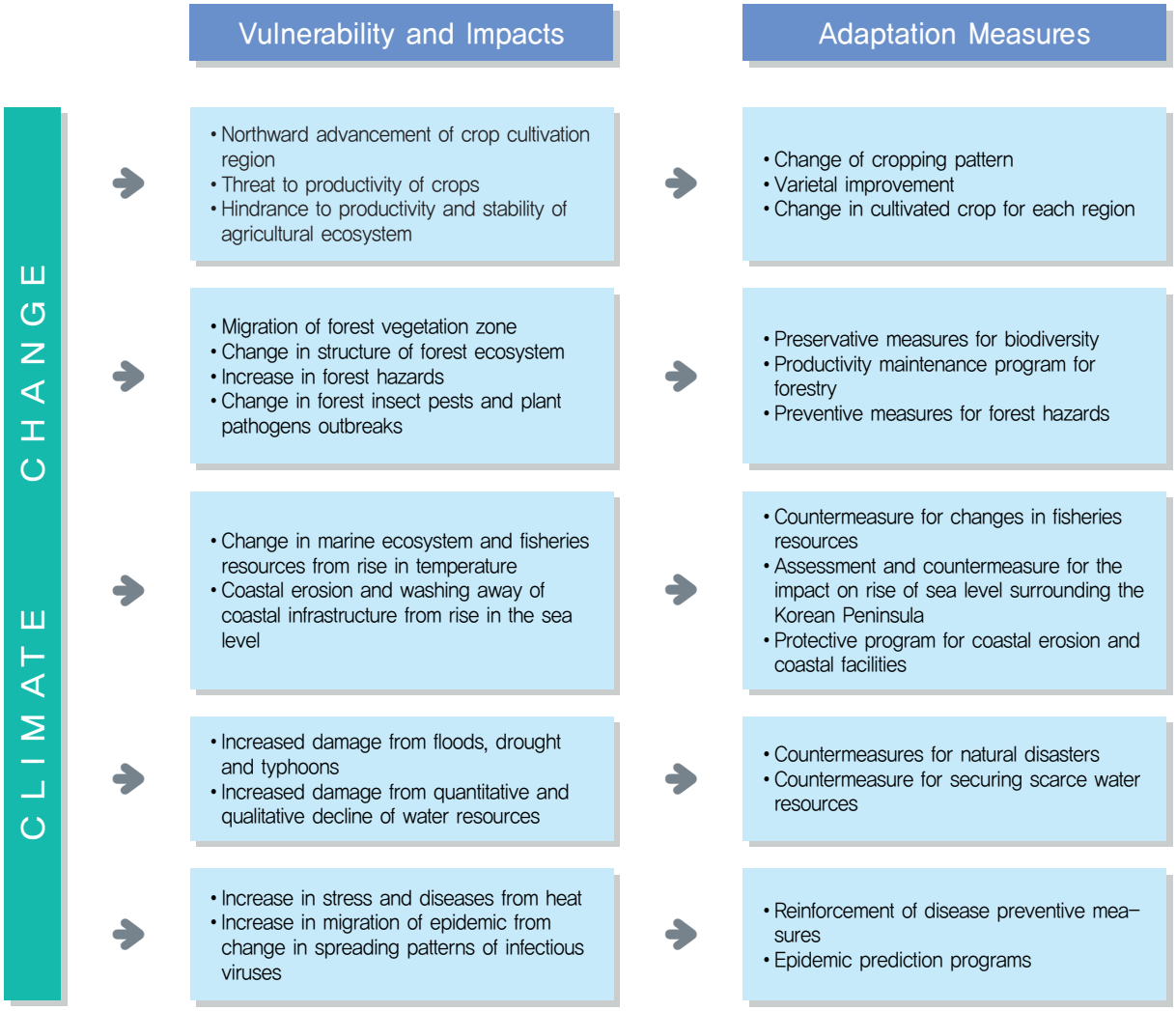
Chapter 6 Vulnerability Assessment, Climate Change Impacts and Adaptation Measures

Chapter 6 Vulnerability Assessment, Climate Change Impacts and Adaptation Measures

1. Outline

Climate change is projected to seriously impact agriculture, forestry & fisheries, the coastal and marine environment, terrestrial ecosystem, natural disasters, health, etc. This chapter summarizes ongoing research activities regarding the impact assessment of climate change on various socio-economic and natural systems, and the development of adaptation measures to mitigate adverse impacts of climate change.

In the agriculture, forestry and fisheries, marine environment, and terrestrial ecosystem sectors, the impact of climate change are expected to be severe on cultivated crops, pisciculture and biological species. The impact on the health sector is related to human diseases. Appropriate adaptation measures to counter the impact will be implemented for each corresponding sector, such as husbandry, biodiversity, fisheries, coastal regions, water resource management, human health, and so on. A summary of potential impacts from climate change and adaptation measures in Korea are shown in (Figure 6-1).



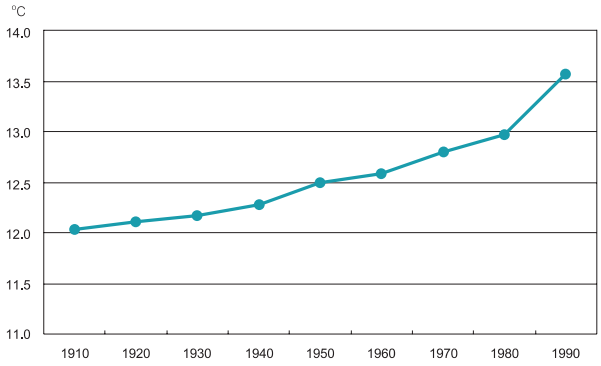
[Figure 6-1] Vulnerability, Impacts and Adaptation Measures for Climate Change in Korea

2. Characteristics of Climate and Outlook on Climate Change

A. Characteristics of Climate

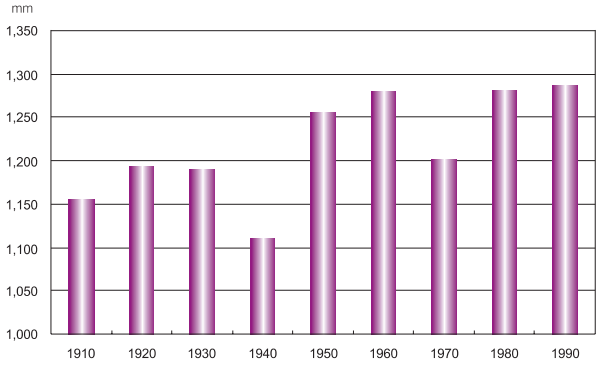
The annual average temperature of the north central region of Korea is approximately 11℃. In the southern coastal region, the annual average temperature is over 14℃, resulting in approximately 3℃ difference between the two regions. The western plains and inland mountains which are on the same latitude show approximately 4℃ difference in the annual average temperature.

Seasonal temperature variation in Korea is distinctive with wide ranges in average temperatures. Winters (November ~ March), affected by the continental climate, are cold and relatively long with wide temperature differences among regions. Summers (June ~ September) are hot and humid due to the East Asian monsoons and the influence of heat and humidity of oceanic climates, resulting in less regional temperature differences compared to those of the winter. Annual temperature ranges are between 22℃ and 30℃, which tend to be wider to the north, west, and inland regions.



Note: Average temperatures at 10-year intervals for 6 stations (Seoul, Gangneung, Incheon, Daegu, Busan, Mokpo) using long-term observational records. 1910, for example, reflects decadal-average of 1911-1920, and so on.

[Figure 6-2] Trend of Average Temperature in Korea (1911~2000)



Note: Average rainfall at 10-year intervals. 1910, for example, reflects decadal-average of 1911-1920, and so on.

[Figure 6-3] Trend of Average Rainfall in Korea (1911~2000)

The temperature observational record for Korea indicates that the average temperature has been rising gradually during the past 90 years. Historically, the temperature rise was highest in the 1990s. The decadal average precipitation has been increasing, however the level of precipitation was comparatively low in the 1910s, 1940s and 1970s, resulting in relatively dry periods.

Extreme analysis for the daily maximum and minimum temperatures shows that frequency of extremely low temperatures in the winter have sharply decreased whereas the frequency of extremely high temperatures in the summer has slightly increased. Such tendencies are more pronounced in the inland region than the coastal.

The data recorded for the southern region of the Korean Peninsula shows that in the recent 20 years, the rainfall intensity[20] has increased by 18% resulting from increase of annual rainfall by 7% and decrease of annual number of rainy days by 14%. Accordingly, frequency of extreme heavy rainfall has also increased. Days with heavy rainfall of over 50 mm have increased by 22 ~ 25%. The increase of rainfall amount in the summer season and the decrease of number of annual rainfall days in the fall season clearly result in the increase in frequency of heavy rainfalls, overall increase in rainfall amount, and decrease in frequency in non-heavy rainfall. In the southern region, the decrease in the number of rainy days has been caused by the decrease in the number of days with non-heavy rainfall, and the increase of rainfall has been caused by the increase in frequency of heavy rainfalls.

B. Outlook on Climate Change

The result of long-term (1860 ~ 2100) A2 (B2) scenario[21] simulation using a coupled Climate Model[22] performed by the Meteorological Research Institute shows that at the end of the 21st century, the global temperature will rise by approximately 4.6℃ (3.0℃) with CO_2 concentration of 820 ppmv (610 ppmv), which is higher than the present

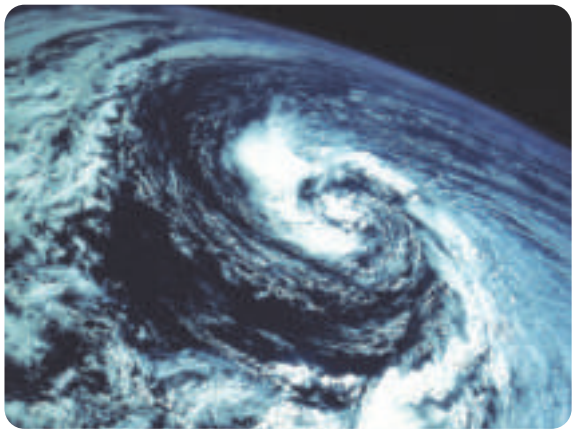
20) Annual rainfall is divided by the annual number of rainy days.
21) A2 and B2 Senarios of IPCC Special Report on Emissions Scenarios (1999).
22) ECHAM4/HOPE model of Marx Planck Research Center in Germany.

level.[23] In East Asia (80°E ~ 180°, 20°N ~ 60°N), the temperature is projected to rise by approximately 6.5°C (4.5°C) compared to the global average. The average rainfall in 2100 will increase by approximately 4.4% (2.8%). The rainfall in East Asian territories is projected to increase by approximately 10.5% (6.0%).

A ensemble analyses with various future climate change scenarios were carried out to project temperature and precipitation trends in the East Asian region in the 2020s and 2050s. The result indicates that the temperature change based on A2 scenario shows a 1.2°C increase in the 2020s, an increase of 2.4°C in the 2050s and 4.0°C in the 2080s. B2 scenario indicates a temperature increase of 1.2°C, 2.3°C and 3.0°C, respectively. The average rainfall in East Asia shows an increase of 0.6%, 2.4% and 5.4% for scenario A2, and 1.4%, 2.6% and 4.0% for scenario B2. Seasonal projection indicates that the rise of temperature in the winter and spring is slightly higher than that of the summer. Furthermore, it is projected that the rise in temperature will be the highest in the north-western region of East Asia, and increase in rainfall will be the greatest along the coastal regions of the Eurasian Continent.

C. Occurrence of Natural Disasters

Between 1991 and 2001, 96.4% of all natural disasters were caused by typhoons, heavy rainfall or storms. Damages from heavy snowfalls and strong tides recorded 3.6%. Heavy rainfall usually occurs in the summertime. Records of the Korea Meteorological Administration stations show that the 90% of the five most extreme heavy rainfall events of any station occurred in July ~ September,



whereas June accounted for 8% and the others 2%. Heavy rains are caused by local heavy rainfalls and typhoons. The month of the highest frequency of heavy rain is August accounting for 45% of the total rainfall. Annual frequency shows that heavy rainfall since 1990 has accounted for more than half of the total, indicating more frequent heavy rainfall tendencies in recent years.

3. Impact on Agriculture, Forestry and Fisheries

A. Impact on Agriculture

The impact of global warming on agricultural ecosystem can be classified into primary and secondary impacts. The primary impact is the change in the air components such as CO_2, CH_4, NOx, SOx and others which will result in the change in growth reaction of crops, energy balance and water balance within the community of arable land. The secondary impact is the effect resulting from the change in the agroclimate resources of the primary impact which is produced by the change in suitable land for cultivation, the change in the migration of hazardous regions, and the impact on material gen-

23) GHG emissions greatly increased in scenario A2 with assumptions on economic development as positive. On the other hand, B2 assumes an environment-oriented society that adheres to the UNFCCC with negligible GHG emissions increase.

eration of agricultural ecosystem and environmental conservation functions. Furthermore, change in physico-chemical prosperities of the arable soil followed by dynamic change of soil microbes and stimulation of weathering for soil will occur.

If the temperature rises 3 ~ 4℃ in Korea due to global warming, the culturable period and the culturable region of crops will be expanded, ascending northward. Furthermore, cultivated crops are predicted to diversify and choice of crops will broaden. However, in cases of excessive temperature rise in certain regions of the south, the perennial temperate fruit trees such as apple trees will be difficult to cultivate. On the other hand, the temperate fruit trees (grapes, sweet persimmons, etc.) will thrive in all regions of the country and warm-season fruit trees will be introduced and cultivated with the possibility of expansion.

Rice is a warm-season crop with exceptional adjustment capabilities to hot weather, hence, it is possible to cultivate rice in all regions of Korea. However, considerable change will occur to the adapted cultivar and cropping pattern. Furthermore, when climate change occurs, southern regions will be included in the subtropical climate belt, ideal for the cultivation and expansion of warm-season fruit trees such as tangerine, citron, and kiwi fruit. On the other hand, difficulty is expected in the cultivation of temperate fruit trees (apples, pears, peaches, grapes, etc.), which are current major crops. If the temperature continues to rise, a part of the apple growing region may have to abandon the cultivation of apples. The expansion of safe regions for cultivating pears, peaches, grapes and sweet persimmons and warm-season fruit trees such as kiwi will be common in the southern coastal regions. In Jeju Island, possibility of cultivating subtropical fruit trees are predicted. As the temperature rises, the best sites and season for cultivating cool-season vegetables will change. The current vegetable growing regions in the highlands will have to migrate to yet higher land for cultivation or ascend north.

B. Impact on Forestry

Most Korean forests are located in a topographically rugged or mountainous areas that are structured in a complex terrain. Prediction of the impact of the expected climate change on the forestry sector is difficult due to high uncertainty of the changes in seasonal patterns of climate and a lack of knowledge about the changes in mountain climate. Korean forests covers 65% of the national territory. Major tree species are *Pinus* spp. and *Quercus* spp., and major planting tree species are *Pinus koraiensis* and *Larix leptolepis*.

It is predicted that as the climate changes, temperature will rise and rainfall will increase, causing CO_2 concentration in the atmosphere to increase and period of growing season to lengthen. This may result in the increase of forest productivity. Contrarily, other limiting factors such as forest fires, landslides, outbreak of insects, pests and plant pathogens may occur as negative impacts. Forests composed of such tree species as the *Pinus koraiensis* which are acclimated to colder environment may decline due to the physiological stress caused by the warmer environment. It is anticiapted that as winter season temperature rises, subtropical pest insects and tree diseases such as pitch canker may increase.

C. Impact on Fisheries

It is predicted that climate change will result in the rise of water temperature and sea level in the surrounding waters of the Korean Peninsula, which will ultimately cause changes in the ocean circulation pattern and sea water characteristics, resulting in the change of the marine ecosystem impacting

the distribution of fisheries resources.

According to the statistics of domestic fisheries for the past 30 ~ 40 years, the catch of warm water fisheries species such as mackerel, anchovy, cuttlefish, etc. has risen, whereas the catch of cold water fisheries species such as walleye pollack, codfish, etc. has decreased sharply. Between the mid-1970s and late 1990s, the winter fishing ground for cuttlefish migrated more than 60 miles to the north in the coastal regions of the East Sea. The catch in the winter season was less than 5,000 tons before the 1980s, however, the number rose to 13,000 ~ 32,000 tons after 1995. The catch of mackerel in the winter season was 3,000 ~ 16,000 tons in the 1970s, but the number increased to 43,000 tons in the 1990s. Furthermore, distribution area of warm water fisheries species in the winter season such as horse mackerel, anchovy, yellow tail, etc. are also migrating to the north.

Water temperature in the winter seasons of the Korean Peninsula increased significantly over a long period. Recently, the appearance of warm water zooplankton has increased with changes in species composition of the major community becoming highly active. The presence of zooplankton and the catch of cuttlefish exposed high correlations.

The northward movement of distribution area of warm water fisheries species seems to be strongly related to the rise in water temperature during the winter seasons of recent years. The phenomenon may possibly signal a change from the currently temperate zone of ocean environs surrounding the Korean Peninsula to a new subtropical zone. A change in the marine environment will lead to a transition between warm water species and cold water species, decreasing the value of fishing grounds and changing the catch of each fisheries species. Furthermore, for marine areas located in the mid-latitude zone such as in Korea's case, cold water and warm water fisheries species are being cultured accordingly to the region. But, in the long-run, as coastal waters become warmer, problems may arise in the culturing of cold water fisheries species and the rearing and cultivating policy thereof.

The rise in water temperature from climate change may induce long-term and large-scale red tide, and cause serious harm to the production of fish and shellfish. Furthermore, the increase in the evaporation of sea water from global warming will result in an increase of terrestrial rainfall and will cause a rise in fresh water input from rivers into the ocean. Hence, salinity of sea water will decrease and nutrient spills from the land will increase, resulting in the increase of seawater eutrophication hazard. Furthermore, in all coastal regions of the Korean Peninsula, serious impact from a rise in the sea level is predicted to be highest in tidal flats. There are vast tidal flats with gentle slopes on the western coast of the Korean Peninsula. Hence, it is predicted that the area of loss will be extensive. In addition, the tidal flats are important ecosystems for pollution purification and biological productivity. Many benthic animals, micro algae, zooplankton,

etc. inhabit this region. It is a place of oviposition, growth and inhabitation for fish. Hence, the loss of tidelands and wetlands due to the rise in sea level will incur a serious decrease in fisheries resources.

4. Impact on the Ocean

Between 1881 and 1990, the average sea surface temperature in the seas surrounding the Korean Peninsula increased by 2℃ in February and 1℃ in August. The winter season increase in temperature during the past 60 years has been 0.019℃/yr., and during the past 30 years 0.035℃/yr., showing an accelerated pace of increase. In the past 30 years, the 1000 m deep upper ocean of the East Sea showed 0.1 ~ 0.5℃ rise in water temperature. Furthermore, the 2000 m deep layer also showed approximately 0.02℃ increase. The change in dissolved oxygen and CFCs in the East Sea appeared to be in accord with the vertical change of the deep water temperature.

By estimating the post glacier rebound corrected rate of change in sea level at tide gauge stations in the sea area environs of the Korean Peninsula, the sea level rise averaged 1.6 mm/yr. and exhibited that it was within the IPCC (2001a) presented range of 1.0 ~ 2.0 mm/yr. The rate of change in sea level for each region of the coastal zone in the Korean Peninsula recorded a range of -0.8 mm/yr. ~ 6.3 mm/yr. for the West Coast, 1.5 mm/yr. ~ 6.9 mm/yr. for the South Coast, and -0.6 mm/yr. ~ 1.9 mm/yr. for the East Coast.

The coastal zone that is directly influenced by the sea level rise is a boundary between the land and the ocean and plays a very important role for human beings. The coastal zone possesses a natural ecosystem that is unique and impossible to substitute such as sandy beaches, tidal flats, coral reefs and marine biota. Socio-economically, the coastal

zones are closely related to people from the utility of transportation, industrial facilities, natural resources, tourism, etc. Korea is surrounded by the ocean on three sides. Geographically, the close cluster of population and the various economic activities are concentrated in coastal zones which reflect the relative importance of the coastal regions.

The coastal zones in Korea regularly experience seawater inundation, marine erosion, seawater intrusion into ground water, etc. from meteorological disasters such as extremely high tide and strong storm surges from typhoons and storms. Casualties in the coastal zone will increase from the superposition of sea level rise, typhoons and rainfall fluctuation, etc. caused by global warming and will greatly impact the socio-economic activities of the coastal zone.

Considering the maximum sea level rise (88 cm) caused by global warming as shown in the IPCC Third Assessment Report as well as the tides and storm surges, the maximum inundated area in the Korean Peninsula is expected to be approximately 2,643 km^2, vulnerably exposing 1.2% of the total territory, when the sea level rises by 1 meter. Furthermore, the population in inundated areas accounts for 2.6% of the total, or approximately

1,250,000. Geographically, the west coast of the Korean Peninsula is more vulnerable than the south and east coasts. On the west coast, vulnerability is more acute in North Korea than the South.[24)]

5. Impact on Water Resources

The impact of climate change on water resources is marked by non-stationarity, uncertainty, sensitivity and vulnerability. Accurate results are possible through the socio-economic analysis on climate change, hydrology, ecosystem and water supply and demand, however the limitation of available data accounts for the lack of related research.

The first expected impact is the increase in the threat of floods. When climate change causes an increase in rainfall, the concentration of rainfall in the summertime will increase the perils of flood as well as the frequency. In 1996, 1998 and 1999, there were outbreaks of intense and extended rainfall over wide areas in the northern region of Gyeonggi province. When the predicted flood peril developed with rainfall, the damage was aggravated through the disruption by water flow of the roads, bridges and structures that were constructed without consideration of drainage to counter flood damage.

Furthermore, increase of fluctuation in outflow will also be impacted. Drought in Korea are caused by massive fluctuations in outflow for each year and season, hence, even the average increase in rainwater will not contribute to the relief of water

shortage if the range of change in water fluctuation in outflow increase, but will rather worsen the shortage. The water shortage issue will also impact the quality of water in rivers, fish, riverside ecosystem and landscape.

6. Impact on Terrestrial Ecosystem

Species distribution or species abundance in fauna and flora is determined by land use, life history strategy of the biological population[25)] and competition with other populations. Hence, as the temperature rises, habitats may shrink or disappear for specific plant species limited to alpine and subalpine regions through competition with temperate deciduous broad-leaved tree species along with predicted impacts of change in the water balance for each season. The change in snowfall and period of snowfall in mountain areas may determine the species composition of the biological organisms through the change in strong wind velocity and micrometeorology on the forest floor (temperature,

24) Such vulnerability assessment assumes that the GHG emissions are generated according to the emissions scenario of IPCC Special Report on Emission Scenario (1999). It does not consider the coastal protection structures in the coastal zones nor typhoon retention time. Hence, the vulnerability index provided reflects the maximum inundation possible areas and population, and the potential degree of vulnerability in coastal zones on the Korean Peninsula.

25) Birth, growth, death, seed dispersal, etc.

humidity, evapotranspiration, etc.).

It is expected that the distribution ranges of plants will migrate northward in latitude and upward in altitude according to the warmer environment. However, this may be contingent on the age and lifespan of existing trees, seed dispersal rate of newly vegetated trees, and competition among them. Currently, it is predicted that the potential habitats for sub-alpine forest zone composed of *Abies nephrolepis, Picea jezoensis, Taxus cuspidata* etc. will decrease. Furthermore, the tendency of bud bursting timing for tree leaves and blooming timing for flowers have been observed to occur earlier due to the rise in temperature during the winter and spring. Such changes will not only affect the biodiversity of the forest but also the life cycle of herbs, insects and herbivorous animals on the forest floor.

The change in the environmental elements in the terrestrial ecosystem followed by global warming is almost impossible to predict due to the secondary change from the affects of pest insects and diseases and vegetations on arable land. Currently, it is predicted that the major outbreaks of the problematic *Laodelphax siriatellus, Nepholettix cincliceps, Nilaparvata lugens,* etc. in the southern region will ascend northward and expand to the central regions. It may be possible for mitigated insect pests which found it difficult to survive the winter in the past to live through the winter under the warmer winter climate, hence resulting in simultaneous outbreaks of mitigated insect pests over widespread regions. Furthermore, as the temperature rises, the possibility of weeds developing an advantage over crops will increase, functioning as an element that will greatly deter agricultural productivity.

7. Impact on Health

The direct impact of climate change on health is predicted to result from the outbreak of environmental diseases. The 1994 observation shows numerous deaths by intense heat. But a scientific tool to evaluate the relationship between excessive deaths and meteorological factors has yet to be devised.

Accumulated data of the outbreak of infectious diseases related to climate change in Korea is almost nonexistent. A time series outbreak aspect limited to legal communicable diseases can be grasped, however in reality, reports to medical institution are too low to be used as research data, except for the recurrence of malaria since 1993 with relatively consistent reports in the northern regions of Gyeonggi province.

8. Adaptation Measures

A. Forestry

Multilateral adaptation strategy is necessary for the conservation of biological diversity and for the maintenance of forest productivity to counterbalance the anticipated rapid climate cha-nge. In other words, by anticipating the rapid climate change, ecosystem networks should be established to maintain the connectivity of protected areas to control the migration and establishment of organisms and to conserve diverse species. Forests should be protected through forest hazard prevention programs with preventive measures for forest fires & establishment of forest fire suppression systems and prediction of landslides.

Planting of tree species accustomed to colder environment should be avoided, and researches related to control the cutting time of plantation consisting of such species and to substitute them with other adequate species are needed. In addition, alien pest insects and introduced plant pathogens (esp. those originating from the subtropical region) should be closely monitored through reinforced inspection of quarantine system for imported plants to prevent the possibility of insects, pests and plant pathogens outbreaks. Furthermore, expansion of pest and pathogens outbreak should be restrained through appropriate pest control activities. Finally, overall efforts to implement the ecosystem management operations and to preserve species vulnerable to climate change are being made.

B. Ocean

Long-term monitoring of the change in the marine ecosystem is necessary to predict the shift in fisheries resources resulting from climate change and variations of fishing ground, and to continuously utilize and manage fisheries resources. Hence, to progress with the research related to the above, a correlation analysis between the long and short-term characteristics of climate change and major fisheries resources are being promoted, along with the research to establish operation method for the variation of the ecosystem. Furthermore, fundamental research is being promoted with the recognition that a long-term adaptation program should be established for coastal infrastructure and territorial safety supervision to confront climate change that would cause a rise in the sea level, changes in the path and intensity of cyclones, changes of wave influence, etc.

C. Water Resources

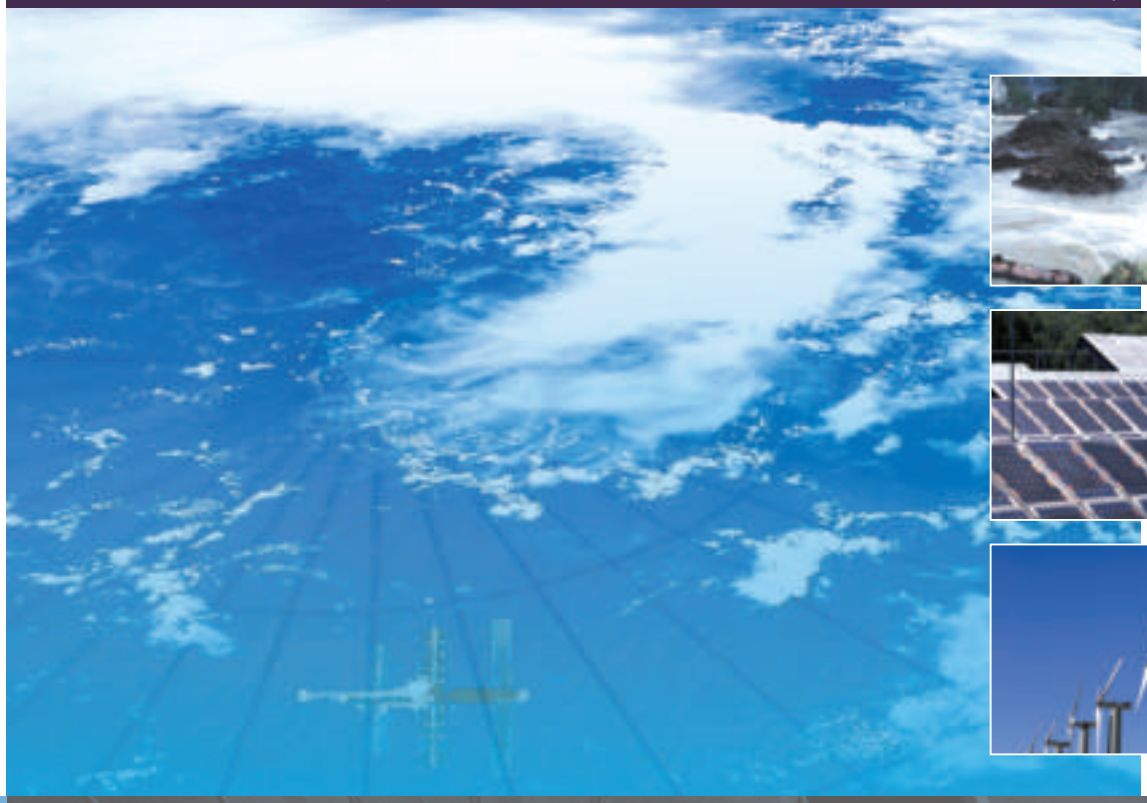
To prepare for natural disasters from climate change, adaptation measures for the water resource sector should be implemented, first of all, by anticipating unforeseen flood and recognizing the extreme value of such anticipation, and promoting among ministries and government agencies integrated countermeasures for floods to achieve colligated restoration and reinforcement from floods. Furthermore, to confront the uncertainty of climates, efforts are being made to establish a systematic and accurate structure that will communicate early warnings to the central government and local authorities to enhance the efficiency of water resource management and minimize the damage from disasters. To increase the accuracy of the flood outbreak estimation, accurate data on sluice control must first be acquired to develop a new concept of reliable flood determination method. Fundamental research relevant to such findings is being accomplished.

D. Health

Each year, the Korean Ministry of Health and Welfare and the National Institute of Health make forecasts on the prevalence of malaria, Japanese

encephalitis, cholera, vibrio, vulnificus septicemia and food poisoning. The National Institute of Health accumulates data on prediction projects such as the identification of the station of specimen or vector, the density of mosquitoes that transmit viral disease, temperature, sea water temperature, sea water pollution, salinity of sea water, antibodies of piglets, etc. Furthermore, by building up the monitoring system classified by epidemics, realities of the infectious disease outbreak are being grasped through the report on infectious diseases and improvement of the reporting structure.

Fundamental management system and formation of database for infectious diseases are being established. However, results from scientific research accumulated to estimate the possibility of artificial climate change and change in the distribution of infectious diseases and ecological adaptation have yet to be organized. Furthermore, evaluation of the impact of air pollution on health has been actively implemented recently. However, the data accumulation necessary for evaluation is insufficient to produce solid results.



Chapter 7 Financial Resources and Technology Transfer

Chapter 7 Financial Resources and Technology Transfer

1. Financial Resources

A. Cooperation with Multilateral Institutions and Programs

Korea not only actively participates in greenhouse gas reduction activities of the UN Framework Convention on Climate Change (UNFCCC) but also contributes financial assistance, technologies and resources to support the activities of environment-related international institutions and programs such as the UN Environment Progr-amme (UNEP) and the World Meteorological Organization (WMO).

Korea has made contributions of approximately $4.3 million from 1998 to 2001 towards environment-related international institutions and programs. Approximately $508,000 was contributed to the UNFCCC between 1998 ~ 2001 and approximately $640,000 to UNEP over the same period. Korea's assigned contributions account for about 78.3% of the total contributions made to environment-related multilateral institutions and programs.

Korea is an active supporter of the international community's efforts to preserve the global environment. In May 1994, it became a member of the Global Environment Facility (GEF), which was established for the purpose of supporting global environ-

〈Table 7-1〉 Financial Contributions to Environment-Related Multilateral Institutions and Programs

(Unit: US$)

Classification	Name of Contribution	1998	1999	2000	2001	Total
Assigned Contribution	World Meteorological Organization (WMO)	154,406	179,311	201,217	383,000	917,934
	International Tropical Timber Organization (ITTO)	225,000	201,691	201,691	165,237	793,619
	Vienna Trust Fund	1,756	9,828	2,902	2,902	17,388
	Montreal Protocol Trust Fund	29,937	29,417	36,128	29,051	124,533
	Northern Forum	10,000	10,000	10,000	10,000	40,000
	Basel Convention	33,398	40,249	40,954	40,832	155,433
	Convention on Biological Diversity (CBD)	52,333	74,816	80,444	88,337	295,930
	UN Convention on Combat Desertification (CCD)	–	–	95,290	154,290	249,580
	Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	36,924	33,964	87,913	66,992	225,793
	UN Framework Convention on Climate Change (UNFCCC)	81,324	207,127	104,647	115,421	508,519
	Subtotal	625,078	786,403	861,186	1,056,062	3,328,729
Project Contribution	UN Environment Programme (UNEP)	160,000	150,000	150,000	180,000	640,000
	UN Human Settlements Programme (HABITAT)	30,000	15,000	15,000	15,000	75,000
	International Tropical Timber Organization (ITTO)	30,000	50,000	20,000	50,000	150,000
	East Asian Seas Action Plan (EAS)	15,000	15,000	15,000	15,000	60,000
	Subtotal	235,000	230,000	200,000	260,000	925,000
Total		860,078	1,016,403	1,061,186	1,316,062	4,253,729

ment protection activities among developing countries. Korea contributed $5.5 million during the first term (July 1994 ~ June 1997) and again du-ring the second term (July 1998 ~ June 2002). Another $5.5 million was contributed to the third term of the Global Environment Facility which began in July 2002.

As the Korean economy plays a more significant role in the world economy, its level of contribution continues to grow. By making contributions that complement its status in the world economy, Korea is strengthening its cooperative relationship with multilateral institutions and programs for environmental protection.

B. Cooperative Development Programs for Developing Countries

The cooperative development programs for developing countries operated by the Korean government consist of grants and loans. Grant aids are implemented and administrated by the Korea International Cooperation Agency (KOICA) through development research, project-type cooperation,

support to NGOs, dispatch of experts and so on, whereas loan aids are carried out by the Export-Import Bank. In the past, such cooperative development programs focused on promoting trade and investment, fulfilling basic human needs and developing human resources. Nowadays, the focus is directed at promoting sustainable development, strengthening partnerships with developing countries and instilling in them a higher sense of the responsibilities of ownership towards development projects. Furthermore, the environment, eradication of poverty, women's development and overpopulation have emerged as major issues for cooperative development.

■ Grant Aid Program

Grant aids implemented and administrated by KOICA concentrate on neighboring countries in the Asia-Pacific region where about 50% of the total budget is spent. Approximately $455.1 million was spent on supporting 164 countries and 41 international organizations between 1991 and 2001. In 2001, in particular, about $54 million was provided as grant aids, of which around $25 million was used to support such countries as Vietnam, the Philippines, China, Indonesia, Mongolia, Sri Lanka, Nepal, Egypt, Cambodia and Kazakhstan.

Development Study Program

The Development Study Program provides developing countries with grant-type technical services which include feasibility studies for their high-priority socio-economic development projects. This technical grant aid assists developing countries with research on master plans, basic studies, feasibility studies and implementation designs and preparation for a variety of projects. A task force composed of qualified specialists is dispatched from engineering companies in Korea to conduct field survey to review and analyze the proposed project in terms of technical, economic and other key factors. Upon completion of the survey, a final report is forwarded to the recipient government.

Project-type Cooperation

Project-type cooperation comprises integrated aid programs which assist developing countries to achieve economic and social development in various areas. The formalities of processing a project-type cooperation consist of identification, screening, planning, implementation, and evaluation over a period of two to five years, usually by combining various types of cooperation such as physical cooperation, that is, tangible components like construction of buildings & facilities, and provision of equipment and materials, with intellectual cooperation such as human resources which includes dispatch of experts and invitation of trainees.

The physical and human resources cooperation required for aid programs are provided in line with demand analysis and negotiations with recipient countries. In general, recipient countries provide the project site and local manpower, and bear local costs such as customs clearance, transportation, and administration, while KOICA provides materials, equipment and technical manpower resources.

The areas covered by such projects include education, vocational training, health and medical services, information technology (IT), agriculture, fisheries, public administration and other fields. KOICA's strategy for success however has been to focus largely on education, vocational training, IT, healthcare and medical services including all areas where Korea has a comparative advantage and competitive priority.

A major example of a project-type cooperation is the five-year afforestation project to prevent

desertification in five northwestern regions in China: Tongliao County of the Inner Mongolia Autonomous Region, Baiyin County of Gansu Province, Turpan County of Xinjing Province, Guiyang County of Guizhou Province and the Ningxia Huizy Autonomous Region. Recognizing the seriousness of the desertification in China, the Chinese government set a goal known as the Project for China West Development by 2050 and implemented a desertification prevention policy. The project was launched upon request of the Chinese government to which the Korean government contributed $5 million in grant aid and other related technologies.

Support to NGOs

The NGO support program is a cooperation program designed to support overseas aid activities conducted by Korean NGOs mainly targeting poverty relief and enhancing public welfare in developing countries. Aid programs administered by NGOs, with the participation of the general public, can effectively facilitate sustainable human development, increase in income, and meeting basic human needs including health care, sanitation, education, and housing. The NGO support program is carried out widely in developed countries as an extension of the ODA sponsored by the government.

〈Table 7-2〉 Status of Grant Aids Assisted by the Korea International Cooperation Agency (KOICA)

(Unit: 1,000 US$)

Classification	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Total
Asia (Number of Countries)	4,667 (18)	5,126 (17)	7,341 (17)	11,170 (21)	15,479 (17)	18,568 (19)	18,544 (18)	11,808 (21)	19,044 (21)	22,667 (19)	24,654 (19)	159,069
Middle-East Asia (Number of Countries)	1,034 (14)	1,592 (16)	1,673 (16)	3,282 (18)	3,862 (18)	3,559 (16)	4,604 (19)	5,319 (18)	1,756 (14)	1,660 (19)	1,952 (18)	30,294
Africa (Number of Countries)	4,902 (37)	5,424 (39)	5,112 (40)	5,105 (40)	6,245 (43)	5,887 (40)	4,896 (35)	3,382 28)	2,215 (29)	4,215 (36)	3,182 (35)	50,564
Central-South America (Number of Countries)	3,514 (31)	2,985 (29)	3,594 (28)	3,554 (30)	3,616 (26)	4,216 (30)	7,812 (31)	4,683 (26)	2,539 (32)	3,800 (29)	3,101 (31)	43,415
Oceania (Number of Countries)	879 (10)	1,328 (11)	1,084 (11)	1,031 (10)	1,423 (12)	1,531 (11)	1,719 (12)	822 (11)	671 (8)	476 (5)	643 (11)	11,606
Eastern Europe & CIS (Number of Countries)	747 (10)	1,105 (16)	1,366 (21)	2,349 (24)	3,581 (23)	4,892 (24)	4,516 (24)	2,992 (22)	3,023 (24)	3,696 (25)	5,860 (24)	34,126
International Organization (Number of Organizations)	706 (7)	645 (9)	849 (8)	1,379 (8)	1,800 (11)	1,582 (15)	2,001 (15)	1,575 (16)	979 (12)	946 (11)	5,337 (15)	17,799
Others	6,392	11,823	9,428	10,424	13,222	13,506	11,382	7,861	7,702	7,891	9,281	108,912
Total (Countries/ International Organizations)	22,840 (120/7)	30,028 (128/9)	30,448 (133/8)	38,295 (143/8)	49,228 (139/11)	53,741 (140/15)	55,473 (139/15)	38,442 (126/16)	37,930 (128/12)	45,351 (133/11)	54,010 (138/15)	455,786 (164/41)

Dispatch of Experts

The Dispatch of Experts Program sends Korean experts from various fields to developing countries for a specified period (from one month to a year), allowing them to transfer Korea's experience, knowledge, and skills acquired in the process of its economic development and share their professional expertise through field-education, seminars, and policy consultation to promote economic and human resources development in developing countries.

There are two forms of Dispatch of Experts: dispatch by nation and dispatch through international organizations. Dispatch by nation is determined through bilateral agreements concluded after a request for dispatch by the government of a recipient country. Dispatch through international organizations is settled once a request for dispatch is made by an international organization. Experts are dispatched to developing countries to serve either in government organizations, public institutions, research institutes and universities, or international organizations such as the Association of Southeast Asian Nations (ASEAN), the Mekong River Commission (MRC) and the Asian Institute of Technology (AIT).

■ Loan Aid Programs (Economic Development Cooperation Fund)

The Economic Development Cooperation Fund (EDCF) was established in 1987 to promote economic cooperation with developing countries by assisting in the promotion of industrial development and economic stability. Governments of developing countries are provided with assistance in implementing projects that contribute to economic development, environment, public health & sanitation, power generation, telecommunication networks and other economic infrastructure. Between 1987 and 2001, Korea contributed about $1.6 billion to 99 projects in 34 countries. Major projects for improving environmental conditions in developing countries include the 1991 wastewater treatment facility project in Jordan ($10 million), the 1996 solid waste treatment pilot project in Anshan, China ($2.5 million), the 1996 second wastewater treatment facility project in Jordan ($9 million), the 1999 hospital wastewater treatment project in Indonesia ($40 million), the 2000 ecosystem & environment improvement project in Inner Mongolia, China ($4.98 million), and the 2001 solid waste treatment project in Vietnam ($19.6 million). The total amount of loan aid contributed by EDCF in 2001 was around $121.6 million for eight projects mainly in five countries including Bangladesh, Vietnam and Cambodia.

C. Other Cooperation Programs

■ Climate-Related Exchanges & Cooperation Programs

In times of surging occurrences of injuries and property damage caused by unusual weather and climate worldwide along with recurrences of El Nino and La Lina, cooperation among nations in finding effective measures to address the impact of climate change is most urgent. Against this backdrop, Korea is sharing related information and technology, exchanging accumulated know-hows with collaborating countries such as Japan, China, Russia and Germany, and actively participating in international cooperation activities such as expert-led workshops, joint meetings, the Asia-Pacific climate network project and expert exchange programs. Moreover, Korea is an active supporter of the Voluntary Cooperation Program and Emergency Assistance Fund managed by the WMO as measures against climate change and the prevention of global warming.

Establishment of the APEC Climate Network

Recognizing the need to establish a regional cooperative system for monitoring and predicting climate change in the Asia-Pacific region, Korea has proposed the establishment of the APEC Climate Network (APCN) for exchanging climate-related information and jointly monitoring abnormal weather patterns in real-time. Such proposal has been met with both approval and support. The purpose of this project, which would install a cooperative system for exchanging climate-related information in real-time by establishing a climate network among APEC member economies, is to put into operation the APEC Climate Prediction Center for monitoring and predicting climate change in the Asia-Pacific region.

In order to establish a multi-model ensemble system that produces and shares climate data, the APCN project utilizes forecast data from APEC members, such as Korea, the United States, Japan, China, Russia, Chinese Taipei, Australia and Canada, which operate the Global Climate Model and produce long-range forecast data using the ensemble technique. The APCN Office at the Korea Meteorological Administration produces multi-model ensemble data which are later distributed among APEC member economies. Furthermore, the APCN working group consisting of experts from APEC member countries develops the multi-model ensemble data producing technique and conducts related research. Korea contributed about $100,000 between 2002 and 2003 for the implementation of this project.

Support for World Meteorological Organization (WMO) Programs

As an active supporter of voluntary activities, Korea has joined the Voluntary Cooperation Program which is operated by the WMO to narrow the disparity in climate change-related technological capabilities among its members. In addition, financial assistance for the Voluntary Cooperation Program is provided to be utilized in the implementation of strategic plans drawn by meteorological agencies in Asian countries. Support for the Voluntary Cooperation Program is planned to be continually expanded.

Furthermore, the WMO has established and is managing the Emergency Assistance Fund to enable quick response to requests by its members for emergency relief during times of war or meteorological disasters. Through the Fund, Korea contributed $50,000 to North Korea in 1996 for repairing equipment damaged by floods and donated a tipping bucket rain gauge to Vietnam in 1999 and 2000 to replace equipment damaged by typhoons and heavy rains.

■ Knowledge Partnership with Asia

Knowledge Partnership is a form of grant aid established for the purpose of disseminating accumulated knowledge and experience on environmental policies, regional environment management, corporate environment management, etc. to other Asian countries. In accordance with the Memorandum of Understanding formed on Cheju Island by the Korean government and the World Bank in February 2001, the Korean government makes an annual contribution of a specified amount in the form of a trust fund to the World Bank which manages the fund for Knowledge Partnership projects.

The Korean government contributed $420,000 to the World Bank in 2002 to support detailed implementation projects and plans to provide similar financial resources in 2003. China, Vietnam and the Philippines have been designated as recipient countries through discussions between the Korean government and the World Bank. The types of projects proposed by the World Bank are investigations, joint research, case studies, international seminars, etc.

2. Technology Transfer

As a member of the Organization for the Economic Cooperation and Development (OECD) and an advanced developing country, Korea can no longer overlook its role in the efforts made by the international community for the prevention of global warming and has examined various potential projects in which to participate. Current projects that promote the transfer of technologies related to energy conservation, improvements in energy efficiency and greenhouse gas reduction are the "KOICA Training Program on Energy Conservation & Utilization Efficiency" led by Korea and the "Climate Technology Partnership - Korea" led by the United States. In addition, multilateral projects for technology transfer are being pursued through the International Energy Agency (IEA) cooperation programs, the Asia-Pacific Economic Cooperation (APEC) programs and various bilateral cooperation programs.

A. KOICA Training Program on Energy Conservation & Utilization Efficiency

Since 1995, KOICA has entrusted the Korea Energy Management Corporation (KEMCO) with the job of introducing Korea's energy conservation policies and programs to energy management per-

sonnel from developing countries such as China, Vietnam, Nepal and Kazakhstan and conducting training programs that include on-site observation of industrial facilities. The purpose of this program is to support greenhouse gas reduction activities by providing assistance to developing countries in the establishment of an energy conservation and management system and to establish the foundation for bilateral cooperation between Korea and the recipient country to form the basis for future cooperation on world energy projects.

The trainee program introduces energy conservation policies and directions such as efficiency management systems, voluntary agreements, projects by energy service companies (ESCO), etc. and technological development policies and directions related to energy including alternative energy. In addition, the program includes on-site observation of such industrial facilities as cogeneration power plants, gas receiving terminals and other energy-related facilities.

The training program lasts about 3 weeks and has been held each year around March and April since 1995 for trainees enrolled by the KOICA. Between 1995 and 2002, a total of 163 energy management personnel from 42 countries have participated in the training program. Korea will continue to utilize this program as a means of transferring technology in the future and plans to carry out its commitment prescribed in UNFCCC Article 4.5 which states the obligation of developed countries to transfer technology related to countermeasures against climate change to developing countries.

B. KOICA Training Programs on Forest Management & Prevention of Desertification

KOICA has been conducting training programs on forest management since 1996 for forest management personnel from developing countries such as Indonesia, Malaysia, Peru and Ethiopia to broaden their knowledge by introducing the latest information on forest management based on Korea's accumulated experience and know-how. The sharing of experience and transfer of technologies related to afforestation, forest recreation, urban forest

〈Table 7-3〉 Status of KOICA Training Programs on Energy Conservation & Utilization Efficiency

Classification	1995	1996	1997	1998	1999	2000	2001	2002	Total
Country	11	9	10	9	14	14	14	11	42 *
Number of Persons	21	18	18	17	20	19	19	31	163

* Overlapping countries are counted only once.

〈Table 7-4〉 Status of KOICA Training Programs on Forestry Management & Desertification Prevention

Classification	1996	1997	1998	1999	2000	2001	2002	Total
Country	13	11	8	11	11	11	21	29
Number of Persons	13	19	15	19	16	17	32	131

management, forest preservation, etc. are essential to ensuring sustainable forest management. Furthermore, since 2001, KOICA has been inviting relevant officials from Asia's developing countries that are seriously affected by desertification to provide training on prevention of desertification based on Korea's experience in afforestation projects. In the above two projects, a total of 131 forestry management personnel from 29 countries were trained between 1996 and 2002, and the number is expected to grow further.

C. Bilateral Cooperation Programs

Based on bilateral agreements, the Korean government promotes bilateral cooperation on energy technology projects with major countries through such activities as joint research, joint seminars and workshops related to energy technology. The range of cooperation has expanded to climate change, regional energy programs, project cooperation and energy supply & demand management. Moreover, active international exchanges are further promoted through joint participation and mutual dispatch of experts in various international projects. The major countries and concrete results of the cooperated projects are summarized in (Table 7-5).

D. Climate Technology Partnership Korea (CTP-Korea)[26]

Korea and the United States concluded an agreement for bilateral cooperation in four major areas including energy technology in September 1998. Since then, the two governments have launched the CTP-Korea Project. The criteria for determining the range of the project and the selection of technologies have been established, and based on the criteria, Energy Audit Technology and the promotion of ESCOs were selected as projects for industrial process and the Methane Recovery and Utilization Technology for the waste sector.

As deemed necessary by the two governments, the Energy Audit Feasibility Cooperation Project was implemented in Korea for industrial process in September 2000. Experts from the United States conducted an initial survey for this project which introduced advanced audit techniques. Based on the initial survey report by the United States, Korea is seeking to enhance the Waste Heat Recovery Program to a Clean Development Mechanism Program.

26) Climate Technology Partnership(CTP) is a technology cooperation project led by the United States and implemented in accordance with the UNFCCC Article 4.5 (the transfer of environmentally sound technologies and know-how to developing countries). Under the supervision of the U.S. Environmental Protection Agency (EPA), Department of Energy (DOE) and Agency for International Development (U.S.AID), the CTP project is operated by the National Renewal Energy Laboratory and participated by countries such as Brazil, China, Kazakhstan, Mexico and the Philippines.

〈Table 7-5〉 Bilateral Cooperation Programs

Country	Content of Program	Details & Results
Italy	Joint Workshop on Fuel Cells & Joint Research	• Sharing of research results on fuel cells & establishment of joint project (molten carbonate fuel cell) • Continuation of bilateral academic exchanges & exchanges of human resources • Promotion of joint participation in the EU Fuel Cell Program
China	Alternative Energy Working Group & Joint Seminar	• Promotion of joint research on photovoltaic, wind power & biomass Examination of cooperation plans • Formation of joint research projects & basis for Korean companies to penetrate the Chinese market • Agreement to organize the Northeast Asia New & Renewable Energy Forum
Japan	Alternative Energy Joint Seminar	• Promotion of expert exchanges & search for ways to raise mutual understanding of technology • Receipt of advanced energy policies & technological information • Establishment of foundation for exchange program
Australia	Clean Energy Joint Workshop & Joint Research	• Joint research on membrane separation technology (energy-conserving membrane/biological reactor wastewater treatment processes) leading to the formation of a domestic market & providing the basis for entering the world market • Promotion of further joint research project on photovoltaic energy
Mongolia	Government-Civilian Joint Conference on Voluntary Cooperation	• Agreement on implementation of joint research (slated for 2004) for the application of Korea's photovoltaic and wind power technology to severly cold regions of Mongolia

Meanwhile, a technological alliance for the Food Waste Gasification Program was formed in 2001 to utilize methane from waste landfills. A validity research was conducted in one of Korea's waste landfills in June 2002.

In the process of implementing the CPT-Korea project, Korea recognized the need for carbon dioxide reduction projects through ESCOs in order to prevent global warming and, for such projects to be carried out smoothly, the need for joint research on ways to overcome impediments to investments on international greenhouse gas reduction projects. A research team has been formed for this purpose to analyze and improve the fund-raising systems of the ESCOs for the implementation of carbon dioxide reducing projects.

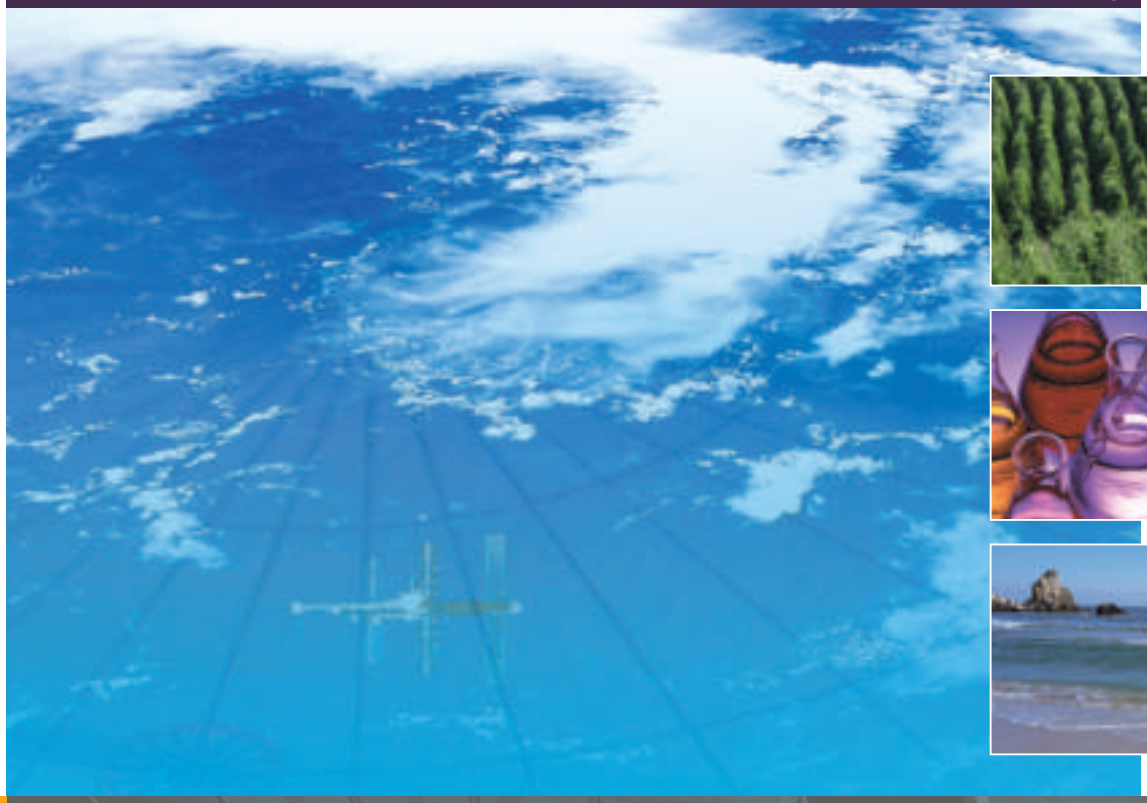
E. International Energy Agency (IEA) Cooperation Program

Korea has joined and is providing assistance by contributing funds and/or dispatching experts to 12 IEA programs including those dedicated to energy conservation technology, alternative energy technology, clean energy technology and technology & information exchange. The 12th International Conference on Photovoltaics was held on Cheju Island in June 2001. Korea also participates in various working groups and expert groups operated under auspices of the Committee on Energy Rese-

arch and Technology (CERT).

F. Asia-Pacific Economic Cooperation (APEC) Program

Technological cooperation is being carried out through APEC's energy working group for the proliferation of alternative energy technology including information exchange, technology standardization, joint research and exhibitions. Korea has participated in conferences for the promotion of energy technology cooperation and the establishment of mid- to long-term technological strategies to resolve energy issues in the Asia-Pacific region through activities by the alternative energy expert group. Efforts are also being made for substantive bilateral cooperation with countries in the Asia-Pacific region such as Japan, China, Australia and the United States.



Chapter 8 Research and Systematic Observation

Chapter 8 Research and Systematic Observation

1. Research and Technology Development Project

During the second comprehensive plan period of the UNFCCC (2002 ~ 2004), Korea has been reinforcing its tools to tackle a variety of issues on climate change. Great efforts in technology have been made through diverse research and developments to derive and analyze direct and indirect impact of climatic change. Furth-ermore, dramatic results have been achieved in the research and technology sectors in the effort to approach the level of developed nations.

Research and technology development projects cover all areas of society including energy, transportation, agriculture and livestock, forestry, the ocean, atmosphere and natural ecosystem at large. Government departments and agencies have established and promoted comprehensive mid- to long-term plans to foster research corresponding to each particular field under scrutiny and to study the distinctive qualities of the relevant responsibilities thereof. Such research and development projects aimed at meeting the objetives of UNFCCC have been implemented not only by the central government, but also by the local authorities. Furthermore, the Korean government has chosen research &

technology development tasks as a core national project and continually provides research funds to the relevant entities.

A. Energy and Industry

In the energy sector, the expansion of the alternative energy utilization base is being pursued to secure technology for clean use of fossil fuels and to simultaneously maximize technology development results for select primary developmental areas as a reinforcement measure for research and technology development projects.

Reduction of greenhouse gases may be considered a complex, energy-related technology development, but, in essence, it possesses characteristics of public technology in which it is difficult for non-governmental sectors to participate. Hence, the Korean government is actively preparing for the UNFCCC by unearthing innovative technologies with high greenhouse gas reduction potential to focus on long-term promotion and the enhancement of the ripple effect of developed technologies, maximizing the mitigation of greenhouse gas emissions through improvements in mid- to long-term national technology development programs.

Active support is being granted to selected research and technology development projects on renewable energy and energy equipment & process technologies. Furthermore, based on the inference that the efforts toward energy conservation and renewable energy technology development is inadequate, carbon dioxide reduction and sequestration has been selected as a core area to be promoted for technology development.

To resolve the problem of the 50% annual increase in PFC emissions by the semiconductor sector, technology development and exchange equipment projects have been promoted to reduce the emissions to 90% of the 1997 level by 2010 for the industrial sector. Between 1999 and 2001, projects on development of HFCs, PFCs, SF_6 reduction technology was conducted to promote the mitigation of PFCs. As a result, the developments for

〈Table 8-1〉 Research and Technology Development on Energy and Industry

Research Area	Contents
Middle and Large Scale Energy Conservation	• Energy equipment and process technology • Energy conservation technology
Next Generation Superconductivity Application	• Development of innovative next generation power equipment and digital devices • Superconductivity power equipment demonstration experiments, commercialized product technology, development of application technology of superconductivity information processing device and commercialization
Carbon Dioxide Capture & Commercialization	• Clean energy technology • Commercialization of carbon dioxide capture & sequestration technologies
Reduction of HFCs, PFCs, SF_6 emissions	• Recall, decomposition, post-treatment, refinement technologies for HFCs, PFCs, SF_6 ; • High efficiency PFCs, SF_6 contained gas mixture utilizing equipment insulation technology • HFCs, SF_6 recovery equipment and standardization of refining quality • Existing system and alternative process optimization technology
High Fuel Economy and Low Emission Vehicles(ISCV)	• High efficiency energy, environmentally friendly, high technology digital vehicles, Hybrid Electric Vehicles (HEV), and Fuel Cell Electric Vehicles (FCEV)

Note: ISCV = Idle Speed Control Valve, HEV = High Technology Digital Vehicle, FCEV = Fuel Cell Electric Vehicle

semiconductor PFC gas treatment scrubber and the core technology parts have been completed. Continuous promotion is being made to research and develop PFCs treatment, alternative gas application, and HFCs, PFCs and SF_6 mitigation technologies.

In addition, carbon dioxide reduction and sequestration technology R&D programs have been selected as a part of the 21th Century Frontier R&D Programs. Hence, the core practical technology development for the three carbon dioxide emission reduction areas with promising potential - oxy-fuel combustion, reaction/separation process, and unused heat recovery - and the infra-technology development for CO_2 sequestration have been promoted.

By securing the economic advantages of new and renewable energy, fossil energy may be substituted by newly developed sources of energy

〈Table 8-2〉 Carbon Dioxide Reduction & Sequestration Technology Development

Research Area	Contents
Oxy-Fuel Combustion	• Development of low cost oxygen production process • Development of intelligent pure oxygen combustion system
Integrated Reaction and Separation Process	• Development of simultaneous reaction/separation process through integration of separated reaction and separation processes • Improvement of energy efficiency and productivity through reduction in reaction temperature and simplification of process
Unused Heat Recovery	• Development of a comprehensive network system to use available energy from unused energy • Development of major unit technology (high efficiency heat exchanger, heat pump system for heating & cooling, long-distance heat delivery technology, large-scale heat storage and supply technology, etc.)
CO_2 Sequestration	• Low cost, high capacity CO_2 capture and sequestration technology • Development of sequential capture process and electrochemical & biological conversion technology

〈Table 8-3〉 Research and Technology Development on Renewable and Clean Energies

Research Area	Contents
Three Priority Development Objectives: Photovoltaic, Wind Power, Fuel Cell	• Selection of technology with commercial viability and significant growth possibility in the renewable energy market • Development of parallel system for technology development and supply of developed technology
Manufacturing Technology for High Efficient Hydrogen Energy	• Development of hydrogen energy resources and the manufacturing system for conversion of hydrogen energy • Development of the core and infra-technology for manufacturing highly efficient hydrogen energy
Superconducting Tokamak Fusion	• Development of a stable-state-capable advanced superconducting Tokamak device with domestic technology • Securing of capability for fusion energy research through development and operation of the advanced superconducting Tokamak fusion
Practicalization of Ocean Energy: Tidal Power, Tidal Current, Wave Power	• Development and practicalization of technology for mass acquisition of the pure and environment-friendly ocean energy • Development of techniques for optimization of Korean tidal power and tidal current power • Development of design for water wheels and flood gates

〈Table 8-4〉 Research and Technology Development on Building

Research Area	Contents
Mid-to Long-Term Strategies for Fostering Energy Conservation	• Development of strategies for energy conservation • Development of measures for energy efficiency improvements • Projection of greenhouse gas emissions from the building sector by using projection model
Fostering Life Cycle Assessment (LCA)	• Program development and system improvement for building LCA • Projection and analysis of the environmental loading in buildings by using the LCA computing program • Calculation of environmental unit loadings in buildings
Fostering Energy Efficiency Certification	• Implementation of grading standards for fostering energy efficiency certification program
Green Building Certification	• Development of assessment criterion for green building certification program

through continuous promotion and proliferation. Furthermore, demonstration and application projects will secure and reflect the technological and economical reliability of the developed technologies. Finally, developed technology will be commercialized through the establishment of an overall foundation.

To focus on the improvement of fostering energy conservation and efficiency in the building sector, research and technology development projects are being actively promoted. For example, research for mid-to long-term action strategies on building energy conservation have been conducted. Furthermore, research for the development of building Life Cycle Assessment (LCA) program and the improvement of relevant systems are being promoted. In addition, basic research for developing the energy efficiency certification and green building certification programs have also been promoted.

B. Transportation

Relevant research and technology development projects have been pursued in the following areas:

〈Table 8-5〉 Research and Technology Development on Transportation

Research Area	Contents
Sustainable Traffic System	• Development of strategies for sustainable traffic system
Traffic/Environment Costs	• Estimation of economic cost of air pollutants and noise • Evaluation of traffic investment projects • Basic materials for transportation policies considering environmental components
Characteristics and Measurement of Vehicle Emissions	• Establishment of analytical techniques for vehicle emissions • Vehicle emission trends, measurement and assessment methods for vehicle emissions, and evaluation of characteristics of emitted air pollutants
Inspection Method for Emitted Gas	• Methods for load tests, assembling of inspection equipment, formal approval, measurement management, etc. • Standardization of equipment and machine for measurement, analysis and test for vehicle emissions
Fuel and Fuel Additives	• Vehicle fuel production standards • Development of fuel additives to reduce emissions



sustainable traffic system,[27] countermeasures for reducing greenhouse gas emissions by local authorities, appraisal of traffic/environment costs, characteristics of vehicle emissions and measurement of emission levels, etc.

C. Agriculture, Livestock and Forestry

In the agriculture and livestock sectors, research and technology development have focused on countermeasures to methane and nitrous oxide emissions. Especially, research and technology development on reduction of methane and nitrous oxide from rice paddies and uplands and methane from manure decomposition have been promoted (Table 8-6).

In the forestry sector, research has been carried out on biomass and greenhouse gas inventory system, soil carbon contents, forest biodiversity and

〈Table 8-6〉 Research and Technology Development on Agriculture and Livestock

Research Area	Contents
GHGs Reduction from Rice Paddies	• Comprehensive evaluation of agricultural practices to reduce GHGs emission • Setup of GHGs emission factors and emission projection due to change of agricultural environments • Evaluation of GHGs emission potential among rice cultivars • Selection and evaluation of rice cultivars low in GHGs emissions
Reduction of Methane from Rice Paddies	• Development of cropping system to reduce methane emissions from rice paddies • Development and propagation of a comprehensive model to reduce methane emissions from rice paddies
Reduction of Nitrous Oxide from Uplands	• Development of methodology to reduce emission of nitrous oxide and NOx from uplands • Development of agricultural technologies to reduce emission of nitrous oxide and NOx
Improvement of Enteric Fermentation of Ruminants	• Estimation and reduction of methane from manure decomposition • Determination of methane emission factor from enteric fermentation of ruminants • Development of technology to reduce methane
Improvement of Livestock Manure Treatment Facilities	• Development of technology to reduce methane from manure treatment • Continuous improvement of livestock manure treatment facilities • Establishment and modernization of composting and liquid manuring facilities
Facilitation Technology for Biomass and Methane	• Development of technology to facilitate biomass/biogas resources • Development of technology to facilitate methane

27) Sustainable traffic system means minimum environmental pollution and maximum ecosystem conservation to continuously improve the quality of life.

〈Table 8-7〉 Research and Technology Development on Forestry

Research Area	Contents
Greenhouse Gas Inventory System	• Measurements of the changes in carbon stocks due to human-induced activities in the LULUCF sector • Establishment of a country-specific GHGs inventory system in the LULUCF sector in consideration of the IPCC guideline and the Good Practice Guidance
Carbon Cycling and Carbon Contents in Forest Soils	• Soil carbon storage and decomposition of organic matters in forests • Forest management system and restoration methods for the forest land degraded by artificial or natural disturbances • Forest soil management system for maintenance of forest productivity
Forest Biodiversity and Forest Ecosystem Change	• Understanding and monitoring the changes of the structure and function of forest ecosystems due to global environmental changes • Establishment of ecological network for the conservation of forest biodiversity and protection of vulnerable forest ecosystems
Ecosystem Change and Restoration Methods in Forest Area Damaged by Forest Fire	• Management system and restoration methods for areas damaged by forest fires • Investigation of forest ecosystem changes in areas damaged by forest fires

forest ecosystem change due to global warming, etc. (Table 8-7).

D. Atmosphere and Environment

Research and technology developments have been promoted to predict and monitor climate change and the environmental impact. For atmospheric monitoring, research has been carried out with a focus on monitoring GHGs concentration in the Korean Peninsula and development of climate change measurement technologies. Furthermore, research on the assessment of the socio-economic environmental impacts of climate change, the correlation between climate change and human health and the development of policy measures have also been implemented. In addition, the integrated cli-

〈Table 8-8〉 Research and Technology Development on Atmosphere and Environment

Research Area	Contents
Atmospheric Composition Monitoring	• Cooperation with international monitoring program on the GHGs and aerosols • A study on monitoring global atmospheric composition • Improvement of analysis techniques on GHGs and atmospheric environment
Climate System Monitoring	• Global ocean observation and forecasting program • Assessment of climate changes in Korea based on the observation and paleoclimate proxy data
Climate Change Prediction	• Development of climate system model and regional model • Development of regional climate change scenario over East Asia • Development of short-term climate and ENSO prediction system
Development of Environmental Technology	• Balance analysis and monitoring technology for GHGs on the Korean Peninsula • Integrated monitoring technology development for GHGs • Balance analysis/evaluation and genesis for GHGs
Climate Change Impact Assessment	• Socio-economic-environmental impact assessment of climate change • Development of integrated climate change impact model • Sectoral and regional adaptation strategy

〈Table 8-9〉 Research and Technology Development on Ocean

Research Area	Contents
Impact on the Marine Ecosystem and Fisheries Resources	• Understanding the structural and functional changes in the marine ecosystem due to climate change and prediction of long-term variations • Understanding the response mechanism of the marine ecosystem • Development of biological index species for oceanic warming and establishment of monitoring system • Understanding the fisheries resources fluctuation and its prediction
Temperature Increase and Sea Level Changes	• Construction of database for the long-term changes in temperature and sea level around the Korean Peninsula • Investigation of the long-term changes in the sea level around the Korean Peninsula and projection of future changes
Technology Development for Marine Methane Hydrate	• Construction of the overall database about resource potential and delineation of the distribution for natural resources • Development of exploration, development, production, transportation, storage and utilization technologies for commercial exploitation of methane hydrate resources
Antarctic Research	• Research on the marine biological resources and marine ecosystem • Study on glacier, atmospheric environment and ozonic layer

mate change impact model has been developing to formulate sectoral and regional adaptation strategies.

E. Ocean

The damage from global warming will be most evident in the ocean. Hence, research on the impact of global warming, adaptation strategies and development of relevant technologies thereof have been actively implemented.

2. Systematic Observation

Observation relevant to climate change have been actively implemented with major focus on the atmosphere, ocean and forestry. Furthermore, to efficiently implement the observation activities, collaborative systems with international organizations and groups have also been established for each sector.

A. Atmospheric Observation System

Korea currently operates 89 observatories, 435 sites with automated meteorological observational instruments, 5 meteorological buoys, 2 light beacon stations for weather equipment, and 1 meteorological observation ship to survey the climate through earth, ocean, upper air, satellite, radar, aviation, and earthquakes. At the 89 observatories, 79 synoptic, 6 upper air, 7 radar, and 9 aviation meteorology observations have been deployed.

To observe the anthropogenic causes of global environmental changes and to protect the ozone layer, the "Law on the Restriction of Manufacturing

Specific Materials for the Protection of Ozone Layer" was enacted in January of 1991. Furthermore, in December 1993, the law was amended as a preliminary legal basis for gaining membership into the UNFCCC, and for monitoring of GHGs as well as the ozone layer.

In 1991, the Korea Meteorological Administration (KMA) established a Task Force on Climate Change to develop a plan for continuous observation of greenhouse gases and the ozone layer, and initiated the Development Project of Climate Monitoring System as a part of the major projects of KMA. Through the project, the infrastructure and observational instruments were built. Also, active participation in the Global Atmosphere Watch (GAW) plan has been facilitated by producing and providing observational record on atmospheric components around the Korean Peninsula.

The Global Atmosphere Watch Network currently operated by KMA consists of the Korea Global Atmosphere Watch Observatory in Anmyeondo (WMO GAW station 47132) to observe GHGs, air quality, atmospheric radiation and acid rain; Pohang Meteorological Observatory (WMO GAW station 47138/ GO_3OS station 332) to observe total ozone amount, vertical ozone profile and surface ultraviolet radiation; UV-observing stations (Mokpo, Gosan in Jeju Island, Gangneung); and acid rain observing sites (Gosan in Jeju Island, Uljin, Ulleung Island).

For comprehensive observation of regional air quality, an adequately scaled regional GAW station

〈Table 8-10〉 GHGs Observation Network in Korea

Site	Duration of Observation		
Muan Regional Meteorological Office	August 1995 ~ December 1997		
Anmyeondo (Korea Global Atmosphere Watch Observatory, KGAWO)	April 1998 ~ Present		
Greenhouse Gases	Unit	Observation Method	Major Equipments
Carbon Dioxide (CO_2)	ppm	Time series observation (Every minute)	Non-dispersive infrared analyzer (NDIR)
Methane (CH_4)	ppm	Time series observation (Every 30 minutes)	Gas Chromatograph (GC-FID)
Nitrous Oxide (N_2O)	ppb	Time series observation (Every hour)	Gas Chromatograph (GC-ECD)
Chlorofluorocarbons (CFC_{11}, CFC_{12})	ppt	Time series observation (Every 3 hours)	Gas Chromatograph (GC-ECD)

will be newly constructed at Gosan in Jeju Island by 2006. It is expected that the tasks of GAW and the monitoring capacity of atmospheric component change in the north-east Asia regions including the Korean Peninsula will increase dramatically.

B. Ocean Observation System

Since 1960, the National Fisheries Research and Development Institute has carried out coastal and offshore ocean observations and reported the results through its Annual Report of Oceanographic Observation. The coastal ocean observation is conducted by measuring the water temperatures daily at approximately 40 sites. For offshore marine duties, the East Sea, the Yellow Sea and the South Sea are observed every 2 months at 22 observation lines (the East China Sea: every 4 months at 3 lines) to measure the water temperature, salinity, dissolved oxygen, transparency, water color, plankton, and ocean meteorology for each water depth.

The National Oceanographic Research Institute has established tidal stations in major harbors for continuous observation of sea levels. Currently, sea level observations are being conducted at 31 tidal stations including Incheon and Busan. The tide data is used to evaluate the sea level rise caused by climate change in the coastal areas of the Korean Peninsula.

C. Forest Observation System

The Korea Forest Research Institute has established research sites as subjects for the long term study and monitoring of structure, function and dynamics of the forestry ecosystem according to global environmental changes. The sites are as follows: (1) Mt. Gyebang site, included in the northern cool-temperate forest sub-zone abundant in *Quercus mongolica* Fisch, *Betula schmidtii* Regals and *Tilia amurensis* Rupr.; (2) Gwangneung Experiment Forest site of KFRI, included in the central cool-temperate forest sub-zone abundant in *Quercus serrata* Thunb. and *Carpinus laxiflora* Blume; (3) Namhae Geumsan site included in the southern cool-temperate forest sub-zone abundant in *Quercus serrata* Thunb., *Carpinus tschonoskii* Max and *Stewartia pseudo-camellia* Max; and (4) Samcheok site in east-coastal region that was devastated by a massive forest fire in 2000. At each site, monitoring of the core variables of ecosystem change are being made at regular intervals such as the stand structure, species composition, net primary productivity, biological diversity, water and nutrients cycling, air pollution, leaf area index and phenology, and various forest micrometeorological factors. At the Gwangneung Experiment Forest site, on the one hand, a flux tower and measurement system was set up for the monitoring of net ecosystem exchange of carbon dioxide, energy and water vapor between the atmosphere and forest ecosystem.

D. International Cooperation

Currently, Korea is actively participating and cooperating in global atmosphere observation activ-

ities and programs such as International Geosphere-Biosphere Programme (IGBP) and Global Climate Observing System (GCOS) focusing on Global Atmosphere Watch (GAW) led by the World Meteorological Organization (WMO). For example, the Korea Meteorological Administration, Ministry of Agriculture & Forestry, Ministry of Maritime Affairs & Fisheries, National Fisheries Research and Development Institute, and Korea Ocean Research & Development Institute are actively participating in sub-programs of the GCOS such as the GCOS Surface Network (GSN) and GCOS Upper-Air Network (GUAN).[28] Korea is also expanding its participation in GCOS collaboratives such as the Global Ocean Observing System (GOOS)[29] and Global Terrestrial Observing System (GTOS). The Anmyeondo Korea Global Atmosphere Watch Observatory participated in the GAW and is recognized as an international observatory.

In the forestry sector, Korea is participating in international activities by establishing the KoFlux in 2002, a regional network of the international Flux network, to monitor carbon levels in diverse terrestrial ecosystems and the inflow and outflow of energy and water.

Furthermore, Korea has actively participated in international activities by holding a general meeting for North Pacific Marine Science Organization (PICES) in 1997, promoting the Circulation Research in East Asian Marginal Seas (CREAMS) in 2002, and hosting the joint symposium for PICES. Korea is also participating in the Surface Velocity Program (SVP) of the World Ocean Circulation Experiment (WOCE) and the Korean Array for Real-Time Geostrophic Oceanography (ARGO, 2001 ~ present).

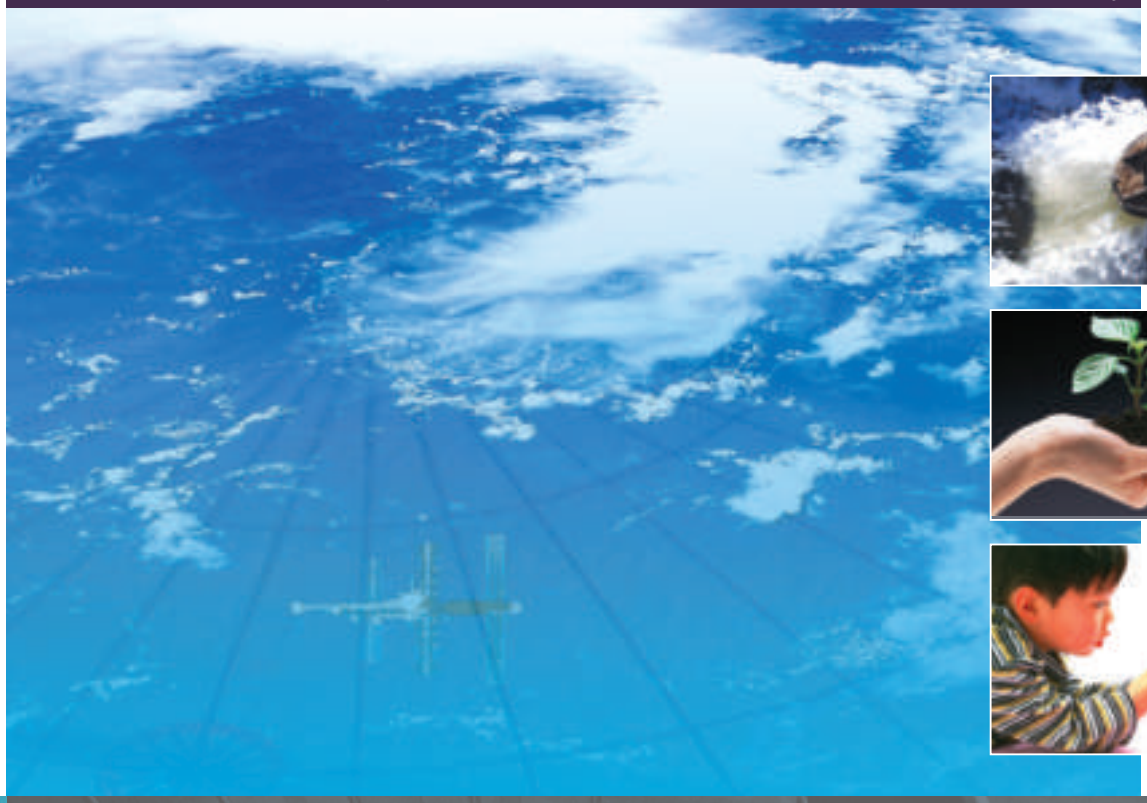
3. Information Exchange

Information exchange activities related to climate change in Korea are being implemented through international symposiums, publication of research results in academic journals, and initiating mutual exchanges among research centers and uni-

28) At the 5th Conference of the Parties to the agreement (Decision 5/CP. 5), GCOS was recognized as the sole international system to estimate and evaluate climate changes.
29) GOOS information exchange is being made internationally real-time and non-real-time by Korea Oceanographic Data Center (KODC) and others.

versities. Recently, reciprocal information sharing is being implemented through electronic networks such as websites of related institutions and electronic libraries.

- Ministry of Commerce, Industry and Energy ..... www.mocie.go.kr
- Ministry of Environment ..... www.me.go.kr
- Ministry of Agriculture and Forestry ..... www.maf.go.kr
- Ministry of Science & Technology ..... www.most.go.kr
- Ministry of Maritime Affairs & Fisheries ..... www.momaf.go.kr
- Korea Meteorological Administration (KMA) ..... www.kma.go.kr
- KMA, Climate Change Information Center ..... www.climate.go.kr
- Korea Forest Service ..... www.foa.go.kr
- Korea Energy Economics Institute ..... www.keei.re.kr
- Korea Energy Management Corporation (KEMCO) ..... www.kemco.or.kr
- KEMCO, Climate Change co2.kemco.or.kr
- Korea Institute of Energy Research ..... www.kier.re.kr
- Korea Forest Research Institute ..... www.kfri.go.kr
- National Institute of Agricultural Science and Technology ..... www.niast.go.kr
- National Livestock Research Institute ..... www.nlri.go.kr
- Korea Ocean Research & Development Institute ..... www.kordi.re.kr
- National Fisheries Research and Development Institute ..... www.nfrdi.re.kr
- National Oceanographic Research Institute ..... www.nori.go.kr
- Environment Management Cooperation(EMC) ..... www.emc.or.kr
- EMC, Climate Change ..... www.gihoo.or.kr



Chapter 9 Education, Training and Public Awareness

Chapter 9 Education, Training and Public Awareness

1. Education & Training

Korea is striving to better inform and educate the public about global warming and the UN Framework Convention on Climate Change (UNFCCC) to achieve a national consensus on Korea's commitment towards the international efforts to create an environment that encourages industries and individuals to voluntarily take part in the efforts. As such, systematic educational programs are targeted accordingly by source, means and stage. Education on climate change functions as a means of informing the public about the adverse effects of and preventive measures for climate change. By educating children and young people about the important role they can play in preserving the environment, they will carry into their adulthood a changed perspective and attitude towards the environment that is lasting and deep-rooted and make a positive impact on future greenhouse gas reduction.

A. Utilization of Discretionary Activity Hours at School

The Korean government is utilizing discretionary activity hours at school to provide one-day environmental education programs led by environment experts and is putting together a booklet for this purpose in 2001. Such programs are pursued

on a continuous basis for primary and secondary school students to maximize the effect of early education and the wide use of the booklet is expected to increase public awareness of climate change and energy conservation.

Furthermore, plans are underway to arrange student field trips for on-the-spot experience in energy conservation and to circulate guidebooks published to assist teachers and instructors. Various educational and training programs for the teaching staffs are used to educate and to promote environmental awareness, and self-education programs are also being implemented in schools.

B. Curriculum of Primary and Secondary Schools

The environment is being instituted as an independent subject in the secondary school curriculum to ensure systematic education on energy, climate change and other environmental issues, whereas the environment is introduced in relation to each subject at the primary school level. The government is planning to support the systematic education on environmental issues by developing the criteria for evaluating the effectiveness of the environment programs in high schools. Moreover, the government has encouraged the compiling and publishing agencies to modify or add entries regarding the UNFCCC in textbooks. *The Changing Society* (April 2002), which is a supplementary material used along with textbooks and circulated throughout schools and training institutions for teachers, contains passages describing global warming, changes in the ecosystem and other adverse effects of climate change.

C. Energy Conservation Model Schools

The government is providing grants to thirty-two primary schools and junior high schools nationwide that have been designated as schools for the research of energy conservation policies. Furthermore, government-approved textbooks are put together and distributed to schools to be used during discretionary activity hours to develop educational programs on energy conservation and UNFCCC during classes and extracurricular activities. Energy conservation field trips, lectures and regional community campaigns are additional programs that are being

〈Table 9-1〉 Status of Energy Conservation Model Schools

Classification	Energy Conservation Model Schools	
	Model Schools	Discretion Activity Model Schools
Purpose	To encourage energy conservation in everyday life	To try out textbooks for discretion activities for verification
Activities	• Learn how to teach environment-related programs • Establish Mother's Group for Energy Conservation • Hold recycled product exhibition & bargain sale • Draw up note-taking for practicing energy saving activities • Conduct parent lectures • Develop campaign for regional community • Participate in events such as campaign for energy conservation committment	• Conduct trial application & analysis of discretion textbooks • Participate in events such as campaign for energy conservation committment
Use of Results	• Submit operational report • Share data and results	• Submit report for the use of textbook • Update textbook, etc.

implemented. Early education materials and information are available through the Learning Web on the websites of model schools. Other than previous off-line campaigns for energy conservation commitment, plans are being made to develop on-line energy conservation programs.

D. Environment Conservation Model Schools

The government has been designating model schools for environment conservation every two years since 1985. The schools provide best teaching practices to instill students with positive values towards environmental issues and make environment preservation a part of their everyday lives. The model schools receive government subsidies and educational materials such as videos dealing with climate change and other global environmental issues. The necessity of teaching, the effects of and measures against climate change and how to teach the subject are passed on to teachers at the schools. Furthermore, best practices related to climate change education are selected and seminars on the subject are held.

E. Graduate Schools for UNFCCC Specialization

Three graduate schools have been selected as UNFCCC specialization schools in order to foster experts in UNFCCC-related fields so that a foundation can be formed for specialized research. The designated educational institutions will focus on research related to policy measures, international negotiations, UNFCCC specialists in corporations, statistical analysis, etc. Korea is planning to continue developing more academic projects and to develop UNFCCC research experts in universities.

F. Other Educational Programs

Programs other than those specified above are being implemented in Korea. They are summarized

as follows:

- the theme of UNFCCC is reflected in the curriculum of education & training courses for personnel in relevant fields including those in charge of energy management in industries, especially in the construction sector, and regional government workers who are responsible for energy management;
- visual energy conservation programs are distributed and used as education programs targeting military officers;
- pamphlets to raise public awareness of forest sinks for greenhouse gases are distributed;
- educational programs on the cause of climate change and atmospheric pollution are conducted for those in fields related to hazard prevention and weather & environment;
- over 500 science teachers in primary and secondary schools attend the annual "Weather Education Program for Science Teachers" to better understand the mechanism and cause of climate change; and
- the "Weather Education Program for Women" provides homemakers to expand their knowledge on climate change by learning what climate change is and how it occurs.

2. Publicity & Public Awareness

The government is working to enhance public awareness and form a national consensus on the seriousness of global warming and is forming partnerships with industries and NGOs to enhance the effectiveness of the measures for mitigating climate change. Moreover, the adverse effects of global warming is being publicized throughout the country to motivate the people to participate in the reduction of greenhouse gases. Three different scenarios targeting three specific groups - opinion leaders, people working in industries and the general public - have been implemented for more efficient public relations.

A. Enhancement of Media Coverage

The recurring media coverage of the government's energy conservation campaign introduces various energy-saving methods and best practices. To enhance the effect of the educational programs on energy conservation and global warming, such methods and practices are documented in audio-visual aids and exhibited during educational programs and events held by various government agencies, groups and schools.

Furthermore, various information regarding the outcome of related international conferences, active measures to mitigate climate change, adverse effects and consequences of climate change, and how the public can help reduce greenhouse gas emissions are all available at related web-sites[31] operated by the government and public organizations.

B. Distribution of Publications

Periodicals and single volumes containing the status of UNFCCC negotiations and the efforts by the government and industries on greenhouse gas reduction are being distributed. Public awareness is instilled to convey the importance of practicing energy conservation through alternative means of advertisement: outdoor advertisements for lasting visual effect; various publications; rooftop billboards and neon signs in areas with large volume of crowd traffic; advertisements on subway trains, buses and other means of transportation; and hand-outs. Audio-visual aids are also distributed at the Energy Pavilion to energy management personnel and students.

C. Expansion of Cooperation with NGOs

Projects funded by the government are offered to NGOs through public announcements to proliferate the energy conservation campaign and form a national consensus. The participation and support of the people have contributed to forming the basis for solidifying the energy conservation campaign

31) www.climate.go.kr, www.climatechange.or.kr, co2.kemco.or.kr, www.gihoo.or.kr.

and lowering energy consumption. To further motivate energy conservation efforts by the people, the government runs the campaign in close cooperation with civic groups and related organizations and distributes publications on energy conservation. The Electrical Power Industry Fund is also utilized to boost NGOs' participation in energy conservation projects.

D. Local Agenda 21

Recognizing the importance of establishing a cooperative system among the central government, local governments, NGOs and the citizens for the effective promotion of climate change mitigation measures, the Ministry of Environment, in cooperation with the Ministry of Commerce, Industry and Energy and the Ministry of Government Administration and Home Affairs, has held touring forums through the "Local Agenda 21", which forms partnerships with local governments, local residents, companies and NGOs. The continued education and publicity has helped local governments and residents better understand the issues involved. In addition, action guideline and evaluation indicator for the reduction of greenhouse gases will be developed and distributed in the near future.

E. Green Energy Family

The Green Energy Family (GEF) is a national movement launched by public agencies, corporations and NGOs in September 1995 in recognition of the fact that the efficient use of energy by end-users will not only lower the cost of energy use but also reduce the emissions of greenhouse gases and contribute to the prevention of global warming.

It is a voluntary partnership program in which companies and business sites (offices, commercial buildings, plants, etc.) fitted with conventional lighting equipment, electric motor systems and electrically operated air-conditioners enter into a voluntary agreement with the Green Energy Family Headquarters to install energy-saving improvements in the facilities within a specified period of time.

F. Expansion of the Environment Preservation Movement

To expand public participation in the environment preservation movement, the government has been sponsoring drawing contests, oratorial contests, photo exhibitions and other mind-elevating events across the nation promoting "love of the environment". Furthermore, the Environmental Excellence Award Competition under the theme of "environment preservation" has been held since 1996 in three categories: televised campaign, newspaper & magazine advertisement, photographs & video. Since 1992, the Environment Grand Prize has been awarded, in cooperation with newspaper companies, to citizens, groups or companies that have contributed to environment preservation. Booklets, leaflets and video tapes are some other publications used to raise public awareness of environmental policies and environment preservation.

G. Urban Greening Campaign

The Urban Greening Campaign signifies the government's effort to reduce energy consumption for air-conditioning in cities and provide cleaner atmosphere through the removal of air pollutants by trees. The campaign succeeded in creating 194 green spaces in 2002 on pieces of unused land and school property in cities, establishing 197 small parks and planting trees aligning 1,171 km of road. Plans are underway to implement various best practice programs and establish a Green Network to link forests in and outside cities.

Local governments also participate in the Urban Greening Campaign. The Seoul Metropolitan Government is conducting the Seoul Green Trust Movement, an urban greening project on 0.3 million ha of land to plant trees in neighborhoods, large eco-parks, forest scenery green zones, etc. by 2050. Daegu Metropolitan City has adopted the "Clean and Green Daegu 21" as its agenda for urban afforestation and is promoting detailed action plans and best practices for creating small parks on rooftops of public buildings, along fences and on unused pieces of property.

H. Energy Conservation Events

The government has designated the first Friday of each month as Energy Conservation Day in which a single theme is selected nationwide to be used in educational programs for employees in government agencies and industries. A campaign encouraging the use of public transportation on Energy Conservation Day is also being overseen by the government. In addition, the Promotion Campaign for Energy Conservation is held each year to encourage the reasonable use and conservation of energy, and the Energy Efficiency Award Competition is conducted to inspire people of all ages - may they be students, homemakers or workers in industries - to take a heightened interest in energy conservation. Moreover, secondary school students are invited to join the Youth Energy Corps to become a part of the energy conservation campaign. The experience is expected to guide young people to conserve energy throughout their lives.

I. Environment Day Events

The Environment Day was designated in 1996 to raise public awareness of the need for environmental protection. Various events celebrating Environment Day, including government ceremonies, take place each year. Under the themes "Connect with the World Wide Web of Life" in 2001 and "Give Earth a Chance" in 2002, award ceremonies and celebratory ceremonies took place in June, the campaign month for environment protection.

3. Activities of Non-Governmental Organizations (NGOs)

To exploit the rising public awareness of climate change, numerous NGOs are spearheading active citizen's movements and public enlightenment campaigns through research, PR activities and education. Besides being observers of the environment protection, their range of activities has expanded to include the planning and implementation of policies. Through their close connection with NGOs abroad, they actively contribute to the cause of tackling worldwide environmental issues.

A. Environmental Organizations

The rising importance of resolving environmental issues has increased the number of environment organizations in Korea, especially those actively involved in an independent status or specific professional fields. Campaigns against the destruction of ecosystems, including ecosystems in residential areas, which directly appeal to the public, are gain-

ing momentum and increasingly pursued by religious groups.

Recognizing that unchecked development and supply-oriented industrial policies have serious repercussions on the environment as well as the economy, the government has commissioned the reexamination of the necessity of large-scale development projects which may produce environmental disruption and lead to a waste of budget. Furthermore, private environment organizations such as the Korean Federation for Environmental Movement, Korea Environmental Education Association (www.greenvi.or.kr), Forest for Life Nation Campaign Headquarters (www.forest.or.kr) and Forest Interpreter Association (www.forest.org) are dedicated to educating the public on the environment and ecosystem.

B. Energy-Related Organizations

Energy-related activities by NGOs may be largely divided into three categories: ① environmental improvement and greenhouse gas reduction through energy conservation campaigns; ② preventive measures against the depletion of energy resources and the effects of climate change through expansion of renewable energy; and ③ raising public awareness through climate change prevention activities and monitoring government and corporate measures for the reduction of greenhouse gases.

The NGOs that have been actively involved in such activities formed the Korea Energy Network in which energy conservation campaigns and policy improvements are actively and systematically promoted.

The Climate Action Forum formed under the Korea Energy Network acts as a leading force for civic movements related to the dissemination of climate change information, monitoring of government policies and climate change campaigns.

In addition, efforts are being made by the energy-related NGOs to overcome the energy crisis such as the depletion of energy resources, climate change and environmental pollution. Such efforts include (1) educational and cultural projects to raise public awareness; (2) policy proposal projects which present viable countermeasures and monitor government policies; (3) campaigns for promoting energy conservation and (4) renewable energy projects to demonstrate the possibility of using renewable energy such as wind power and photovoltaic. Furthermore, by becoming members of international environment organizations, the NGOs actively participate in environment protection activities on a global scale.

References

Inter-Ministerial Committee on UNFCCC, *Second Comprehensive Action Plan for UNFCCC*	2002
Korea Energy Economics Institute, *Korea Energy Review Monthly*	Various Volumes
Korea Energy Economics Institute, *Monthly Energy Statistics*	Various Volumes
Korea Energy Management Corporation *Report on the Analysis of US Global Climate Change Research Programme - Analysis of the CCTI*	2000
Korea Energy Management Corporation, *The Handbook of Energy Conservation*	2001
Korea Energy Management Corporation, *The Statistical Handbook of Energy Conservation*	2003
Korea Forest Service, *The 4th Forest Development Plan (1998 ~ 2007)*	1997
Korea Forest Service, *21st Century Forest Vision*	2000
Korea Forest Service, *National Strategy for Sustainable Development-Sustainable Forestry Management Strategy*	2002
Korea Forest Service, *Statistical Yearbook of Forestry*	Various Volumes
Korea Institute of Energy Research, *2002 Frontier Project : Planning Carbon Dioxide Reduction and Sequestration Research and Development*	2002
Korea Meteorological Administration, *Climatological Normals of Korea: 1971-2000*	2001
Korea Ocean Research and Development Institute, *A Study on the Optimization of Tidal Power Generation System*	1997
Korea Ocean Research and Development Institute, *Ocean Circulation in the Mid-Western Area of the East China Sea*	2000
Korea Rural Economic Institute, *2002 Agricultural Projections*	2002
Meteorological Research Institute, *Development of Regional Climate Change Scenario of the National Climate Change Report(1)*	2002
Ministry of Agriculture & Forestry, *Five-Year Plan for Environment-Friendly Agricultural Industry*	2000
Ministry of Agriculture & Forestry, *Guideline for Agricultural Businesses,* Volume 5	2001
Ministry of Agriculture & Forestry, *Major Agriculture, Forestry & Fisheries Statistics*	Various Volumes
Ministry of Agriculture & Forestry, *Yearbook of Agricultural & Forestry Statistics*	Various Volumes
Ministry of Commerce, Industry & Energy and Korea Energy Economics Institute, *Study on Strategies to Address the UNFCCC & Kyoto Protocol, First Year*	2001
Ministry of Commerce, Industry & Energy and Korea Energy Economics Institute, *Study on Strategies to Address the UNFCCC & Kyoto Protocol, Second Year*	2002
Ministry of Commerce, Industry & Energy and Korea Energy Economics Institute, *Yearbook of Energy Statistics*	Various Volumes
Ministry of Construction & Transportation, *Yearbook of Construction and Transportation Statistics*	Various Volumes
Ministry of Environment, *Comprehensive Action Plan for National Waste Treatment (1993-2001)*	1993
Ministry of Environment, *21st Century Vision for Environment*	1995
Ministry of Environment, *Study on Strategies Under UNFCCC*	2002
Ministry of Environment, *Planning on Strategies Under UNFCCC - Environment Sector*	2003

Ministry of Environment, *Environment White Paper*	Various Volumes
Ministry of Government Administration & Home Affairs, *Statistical Yearbook of Land Registration*	Various Volumes
Ministry of Maritime Affairs & Fisheries, *Mid-/Long-Term Implementation Plan for Marine Resources Development*	2000
Ministry of Maritime Affairs & Fisheries, *Development of Utilization Technique for Ocean Energy (I) : Tide/Tidal Current Energy*	2001
Ministry of Maritime Affairs & Fisheries, *Array for Real-time Geostrophic Oceanography (ARGO)*	2002
National Statistical Office, *International Statistics Yearbook*	Various Volumes
National Statistical Office, *Korea Statistical Yearbook*	Various Volumes
National Statistical Office, *Major Economic Indicators of Korea*	Various Volumes
The Bank of Korea, *Annual Report*	Various Volumes
The Government of the Republic of Korea, *National Communication of the Republic of Korea Under the United Nations Framework Convention on Climate Change*	1998

Citizen's Alliance for Consumer Protection of Korea	www.cacpk.org
Energy Regiment	www.enet.or.kr
Environment Management Corporation	www.emc.or.kr
Environment Management Corporation - Climate Change	www.gihoo.or.kr
Green Korea United	www.greenkorea.org
Korea Energy Economics Institute	www.keei.re.kr
Korea Energy Management Corporation	www.kemco.co.kr
Korea Energy Management Corporation - Climate Change	co2.kemco.or.kr
Korea Forest Research Institute	www.kfri.go.kr
Korea Forest Service	www.foa.go.kr
Korea Institute of Energy Research	www.kier.re.kr
Korea Meteorological Administration	www.kma.go.kr
Korea Meteorological Administration - CCIC	www.climate.go.kr
Korea Ocean Research & Development Institute	www.kordi.re.kr
Korea Sustainable Development Network	www.ksdn.or.kr
Korean Federation for Environmental Movement	www.kfem.or.kr
Ministry of Agriculture & Forestry	www.maf.go.kr
Ministry of Commerce, Industry & Energy	www.mocie.go.kr
Ministry of Environment	www.me.go.kr
Ministry of Maritime Affairs & Fisheries	www.momaf.go.kr

Ministry of Science & Technology	www.most.go.kr
National Fisheries Research & Development Institute	www.nfrdi.re.kr
National Institute of Agricultural Science & Technology	www.niast.go.kr
National Livestock Research Institute	www.nlri.go.kr
National Oceanographic Research Institute	www.nori.go.kr
Office for Government Policy Coordination	www.opc.go.kr

NEDO	*Projects for New Energy and Energy Conservation Technology Development NEDO Activities*	2002
IPCC	*Revised 1996 IPCC Guideline for National Greenhouse Gas Inventories: Reference Manual*	1996
IPCC	*Special Report: The Regional Impacts of Climate Change - An Assessment of Vulnerability,* Cambridge University Press	1997
IPCC	*Special Report: Emission Scemarios - Assessment Underlying the SPM*	1999
IPCC	*Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*	2000
IPCC	*Climate Change 2001: Synthesis Report,* Cambridge University Press	2001a
IPCC	*Climate Change 2001: Impacts, Adaptation and Vulnerability,* Cambridge University Press	2001b
IPCC	*Climate Change 2001: The Scientific Basis,* Cambridge University Press	2001c

Appendix Contribution to the Second National Communication of the Republic of Korea Under the UNFCCC

The publication of the *Second National Communication of the Republic of Korea Under the UNFCCC* is the culmination of a joint effort and collaboration by the following participants. (In alphabetical order)

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- Korea Environment institute
- Korea Energy Management Corporation
- Korea Forest Research Institute
- Korea Forest Service
- Korea Institute of Construction Technology
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- Korea Ocean Research and Development Institute
- Korea Transport Institute
- Meteorological Research Institute
- Ministry of Agriculture and Forestry
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