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First Biennial Update Report of the Republic of Korea

Under the United Nations Framework Convention on Climate Change

December 2014

The Republic of Korea

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FOREWORD

I am pleased to present the First Biennial Update Report of the Republic of Korea under the United Nations Framework Convention on Climate Change (UNFCCC).

Extreme climate changes are already affecting millions of people adversely all over the world. Decreasing crop yields, rising sea levels, and the depletion of water resources are urgent problems. Last month, a report from the World Bank, entitled *Turn Down the Heat: Confronting the New Climate Normal,* warned that the Earth's temperature will warm 4℃ above pre-industrial levels by the end of this century. Furthermore, the report stressed that weather extremes and unprecedented heat waves will become '*the new climate norm*', threatening the lives and well-being of countless individuals all over the world. To achieve global carbon neutrality between 2055 and 2070 and keep global temperature increases below 2℃, the United Nations Environment Programme (UNEP) declared in November 2014 that annual anthropogenic CO_2 emissions will have to hit net zero on a global scale.

As a part of an international effort to reduce greenhouse gases, the Republic of Korea has undertaken energetic efforts to do its part in a dawning era of climate responsibility. In January 2014, Korea published a "Roadmap to Achieve the National Greenhouse Gas Reduction Target" to strengthen our country's ability to meet voluntary national greenhouse gas reduction targets set for 2020. In this regard, the "Korean Emissions Trading Scheme" will be implemented as scheduled on January 1, 2015.

Last September, as President Park Geunhye mentioned in her keynote speech at the 69th session of the United Nations General Assembly (UNGA), the Republic of Korea is developing and promoting technological innovations that will encourage the growth of new industries, as well as the creation of new jobs as part of a 'Creative Economy'. I echo the sentiments of President Park before the UNGA: "Korea views climate challenge not as a burden, but an opportunity." We seek to harmonize our continued economic growth—what is often referred to as Korea's Miracle on the Han River—with the development of environmental safeguards. Our nation will also act as a liaison between developed and developing countries and continue to collaborate with developing nations in their efforts to respond to the challenges of climate change. To help achieve these important objectives, Korea will widely share its successful strategies for reducing greenhouse gas.

Korea's First Biennial Update Report details our successes with climate change mitigation until 2012. Specifically, it describes our national circumstances, national greenhouse gas inventory, mitigation actions and their effects, as well as our finance, technology, and capacity building needs and support status.

The environmental challenges before us remind me of an old saying: "The best thing about the future is that it comes one day at a time." Through day-by-day efforts to conserve our environment for future generations, we are taking responsibility for the present and acting as a leader in the international community in this all-important struggle.

Thank you.

Yoon Seong-kyu
Minister of Environment
December 2014

EXECUTIVE SUMMARY

The first Biennial Update Report of the Republic of Korea under the United Nations Framework Convention on Climate Change (UNFCCC) offers new information on GHG emissions reduction from Korea's Third National Communication submitted to the UNFCCC in 2012. It reflects Korea's efforts to reduce Greenhouse Gas (GHG) emissions after the submission of the third National Communication in 2012 by presenting a *Roadmap to Achieve the National Greenhouse Gas Reduction Target*, an implementation plan for the *Emissions Trading Scheme*, etc.

National Circumstances

In 2012, the total population of Korea was estimated at approximately 50,004 thousand, about 0.7% of the world's total population. This ranked Korea as the 25th most populous country in the world. In coming decades, however, an aging society is expected to increase the challenges of supporting a growing number of seniors. The nominal gross domestic product (GDP) of Korea rose by an average annual rate of 3.62% during the past 3 years, showing a consistent increase in GDP. Energy consumption, vehicle registration, and waste generation surged as well.

According to the current status of each sector, Korea's primary energy consumption in 2012 was 278,698 thousand TOE. Coal (38.1%) and oil (29.1%) represented the two largest shares of total energy consumed. Along with more cars being used, passenger travel by road accounted for 88.2% of domestic passenger transport in 2012. Moreover, vehicle registration had increased over fivefold since 1990, reaching its highest level of 18,870 thousand in 2012. In the building sector, apartments accounted for 58.5%, the largest share of total residential housing in 2010. The amount of per capita household waste has steadily decreased under the influence of the volume-based waste fee system.

However, the total amount of commercial and industrial waste and household waste has increased continuously.

National Greenhouse Gas Inventory

The *National GHG Inventory* details national GHG emissions in energy, industrial processes, agriculture, LULUCF (land use, land-use change and forestry), and waste sectors in accordance with the Intergovernmental Panel on Climate Change's Guidelines (IPCC GL) from 1990 to 2012. For quality improvement, deliberation, and approval of the National GHG Inventory, the Management Committee—chaired by the Vice-Minister of Environment—was founded. This body includes a Working Group composed of director-level government officials from relevant ministries and a Technical Group made up of external experts.

To enhance the transparency and accuracy of the national GHG inventory, Korea keeps the measurement and verification processes separate while preparing the national GHG inventory. In the measurement process, relevant ministries review and submit inventory documents prepared by sectoral agencies to Greenhouse Gas Inventory Research Center of Korea (GIR). In the verification process, GIR reviews inventories from each sector and requests additional data and revisions if necessary before producing a verification report and the draft national inventory. After technical assessments and deliberations by the Technical Group and the Working Group, the Management Committee reviews and approves the final draft of the national GHG inventory.

Total GHG emissions in Korea in 2012 were 688.3 million tons of CO_2eq. (excluding LULUCF). This represented a 132.9% increase from 295.5 million tons of CO_2eq. in 1990 and a 0.4% increase from 685.7 million tons of CO_2eq. in 2011. GHG Emission trends from 1990 to 1997 showed an annual increase of over 5% per year. Emissions in 1998 declined significantly due to the East Asian economic crisis but grew again thereafter as the regional economy stabilized and experienced renewed growth. The share of each sector in the total GHG emissions in 2012 is 87.2% for the energy sector, 7.4% for the industrial processes sector, 3.2% for the agriculture sector, and 2.2% for the waste sector, respectively.

Mitigation Actions and Effects

Korea announced its mid-term national GHG reduction target—30% below its BAU level by 2020—in November 2009. Since then, the government has determined reduction targets for each sector and year though a joint task force led by the GIR and relevant ministries in July 2011. Looking into the emissions pathway by year, GHG emissions in Korea was expected to reach their peak in 2014 and begin to decline in 2015. In addition, Korea developed a Roadmap to accomplish national Greenhouse gas reduction targets in January 2014. This plan offers a realistic and effective strategy for each sector to enable Korea to reach its national target for emission reductions. Relevant authorities periodically assess the progress of each sector in reaching its required goals set by the action plan to ensure Korea's successful implementation of the Roadmap.

Since 2010, Korea has operated the Greenhouse Gas and Energy Target Management System (TMS) to manage business entities that are both large GHG emitters and large energy consumers. As of 2014, Korea designated the companies that generate GHG emissions of more than 50 thousand tons of CO_2eq. and consume over 200 TJ of energy annually—or own the facilities generating more than 15 thousand tons of CO_2eq. and consuming over 80 TJ of energy annually—as controlled entities. The outcome of the TMS regulation in 2012 led to the emissions reduction of 21.3 million tons of CO_2eq., which accounted for 3.78% of the 2012 total emission projections (563.6 million tons of CO_2eq.). This reduction—achieved by 392 of 434 controlled entities (90.3 percent of the companies)—was 2.7 times the 2012 national reduction target of 7.95 million tons (1.41% of 2012 emission projections). The industries that contributed most significantly to these emission decreases included petrochemical (6.9 million tons of CO_2eq. reductions), steel (5.73 million tons of CO_2eq. reductions), and semiconductor/display/electrical & electronic industries (5.3 million tons of CO_2eq. reductions).

Furthermore, Korea has actively prepared for the introduction of the Emissions Trading Scheme as part of its efforts to transition to a low-carbon, highly-efficient industrial structure while achieving national reduction targets in an economically feasible manner. In this regard, *the Act on Allocation and Trading of Greenhouse*

Gas Emissions Allowances and the Enforcement Decree Act were established and implemented in 2012. These laws created a legal foundation for the implementation of the Emissions Trading Scheme. In 2014, as related subsidiary plans were created—such as *the Master Plan for the Emissions Trading Scheme and the Phase I National Allowances Allocation Plan*—the government began necessary procedures to commence the ETS on January 1, 2015. Amongst business entities currently under the TMS, those who generate over 125,000 tons of CO_2eq. —or own facilities producing over 25,000 tons of CO_2eq. on an annual average rate of 3 years—are subject to the ETS.

Details of the emissions reduction measures in each sector are as follows. In the energy transformation sector, policies that suppress GHG emissions and treat GHG already emitted into the atmosphere have been pushed ahead simultaneously. The former includes the expansion of new & renewable energy resources, while the latter includes the development of a CO_2 capture and storage system. In the industry sector, Korea is managing the entire phase of energy supply and demand planning including the planning, energy distribution and usage on a national basis—to regulate its needs in a more effective manner. Additionally, in the building sector, Korea exerts every effort to improve energy efficiency from the design phase of buildings to their daily operation. The expansion of public transport infrastructure and increases in the number of vehicles subject to a fuel economy management system are key tools for reducing emissions in the transport sector. For the agriculture, forestry, and fishery sector, mitigation measures—including the development of new technologies for water management in rice farmlands and the expansion of livestock manure-to-energy systems—are widely utilized to reduce CH_4 emissions. Finally, Korea endeavors to reduce CO_2 and CH_4 emissions in the waste sector by minimizing municipal and industrial waste by converting them to energy or by reusing landfill gases.

Chapter 1

NATIONAL CIRCUMSTANCES

Chapter 1. NATIONAL CIRCUMSTANCES

1.1. Government structure

The Republic of Korea is a democratic country with a presidential system of government. The executive branch led by the president comprises the President's Office, the Prime Minister's Office, several independent agencies, and 17 cabinet-level ministries. The executive branch also includes 16 affiliated agencies under their relevant ministries, headed by a vice-minister level commissioner. In February 2009, the government established the *Committee on Green Growth* to maximize the synergy between environment and economic growth and achieve a creative economy.

1.2. Population profile

In 2012, the total population of Korea was estimated at approximately 50,004 thousand. Its population accounted for about 0.7% of the world's total population of 7,021 million, ranking as the 25th most populous country in the world. The percentage of working age population (aged between 15 and 64) of the total population will decrease by 16.3%p from 72.8% (35,983 thousand) in 2010[1)] to 56.5% (28,873 thousand) in 2040. This will exacerbate the burden of supporting seniors in an aging society (Table 1.1.).

Table 1.1. Estimates of Korea's Economically Active Population (2010~2040)

(Unit: thousand persons)

	2010	2020	2030	2040
Total population	49,410	51,435	52,160	51,091
Population aged 15 to 64	35,983 (72.8%)	36,563 (71.1%)	32,893 (63.1%)	28,873 (56.5%)

Source: Population Forecast by Province: 2010-2040, Statistics Korea, 2012

1) The regular interval of Population and Housing Census changed from 10 years to 5 years.

1.3. Economic profile

While Korea's average annual growth rate was 4.9% from 1990 to 2012, the country's annual economic growth rate (real GDP growth rate) declined by 7%p from 9.3% in 1990 to 2.3% in 2012. The country's nominal gross domestic product (GDP) increased by approximately sevenfold from 191,383 billion KRW in 1990 to 1,377,457 billion KRW in 2012. During this period, the per capita GDP rose by approximately sixfold from 4,460 thousand to 27,550 thousand won (Table 1.2.).

Table 1.2. Nominal GDP and Per Capita GDP

	GDP (billion Korean Won, nominal)	Per Capita GDP (10 thousand Korean Won per person)
1990	191,383	446
1995	409,654	908
2000	635,185	1,351
2005	919,797	1,911
2010	1,265,308	2,561
2011	1,332,681	2,677
2012	1,377,457	2,755

Source: Bank of Korea's Economic Statistics System

1.4. Energy

From 1990 to 2012, Korea's primary energy consumption increased at an average annual rate of 5.1%, and the final energy consumption grew at an average annual rate of 4.7%. In addition, per capita energy consumption rose from 2.17 TOE in 1990 to 5.57 TOE in 2012, and the rate of dependency on imports increased by 8.1%p from 87.9% to 96.0% during the same time period (Table 1.3.).

Table 1.3. Change in Energy Related Indices

	Unit	1990	1995	2000	2005	2010	2011	2012
Primary Energy	thousand TOE	93,192	150,437	192,887	228,622	263,805	276,636	278,698
Final Energy	thousand TOE	75,107	121,962	149,852	170,854	195,587	205,863	208,120
Energy Consumption per Capita	TOE	2.17	3.34	4.10	4.75	5.34	5.56	5.57
Energy Consumption per GDP	TOE/thousand dollars	0.259	0.286	0.284	0.271	0.259	0.262	0.258
Rate of Dependency on Imports	%	87.9	96.8	97.2	96.6	96.5	96.5	96.0

Source: 2013 Energy Statistics Yearbook, Ministry of Trade, Industry and Energy and Korea Energy Economics Institute, 2013

In terms of energy consumption by source, oil represented the largest share of the total energy consumed in 2012 at 38.1%, followed by coal at 29.1%, LNG at 18.0%, and nuclear at 11.4%. The share of oil in overall energy consumption declined dramatically from 53.8% in 1990 to 38.1% in 2012. At the same time, the share of LNG rose from 3.2% in 1990 to 18.0% in 2012 (Table 1.4.). This shift in energy consumption was caused by the enforcement of policies encouraging clean energy, as well as the implementation of environmental regulations and a decrease in oil dependency due to high oil prices.

Table 1.4. Primary Energy Consumption by Source

(Unit: thousand TOE)

Fuel / Year	Coal	Oil	LNG	Hydro	Nuclear	Other	Total
1990	24,385 (26.2%)	50,175 (53.8%)	3,023 (3.2%)	1,590 (1.7%)	13,222 (14.2%)	797 (0.9%)	93,192 (100%)
1995	28,091 (18.7%)	93,955 (62.5%)	9,213 (6.1%)	1,359 (0.9%)	16,757 (11.1%)	1,051 (0.7%)	150,437 (100%)
2000	42,911 (22.2%)	100,279 (52.0%)	18,924 (9.8%)	1,402 (0.7%)	27,241 (14.1%)	2,130 (1.1%)	192,887 (100%)
2005	54,788 (24.0%)	101,526 (44.4%)	30,355 (13.3%)	1,297 (0.6%)	36,695 (16.1%)	3,961 (1.7%)	228,622 (100%)
2010	77,092 (29.2%)	104,301 (39.5%)	43,008 (16.3%)	1,391 (0.5%)	31,948 (12.1%)	6,064 (2.3%)	263,805 (100%)
2011	83,640 (30.2%)	105,146 (38.0%)	46,284 (16.7%)	1,684 (0.6%)	33,265 (12.0%)	6,618 (2.4%)	276,636 (100%)
2012	80,978 (29.1%)	106,165 (38.1%)	50,185 (18.0%)	1,615 (0.6%)	31,719 (11.4%)	8,036 (2.9%)	278,698 (100%)

Source: 2013 Energy Statistics Yearbook, Ministry of Trade, Industry and Energy and Korea Energy Economics Institute, 2013

1.5. Transport

According to transport statistics in 2012, travel by road[2] represented the biggest share of domestic passenger transport at 88.2%, followed by subway at 8.1%, rail at 3.9%, aviation at 0.1%, and marine at 0.1% (Table 1.5.). The share of road travel has gradually declined due to the expansion of urban railway networks and the five-day workweek. The share of rail and subway travel increased at the same time because of growing oil prices and the expansion of subway systems.

Table 1.5. Passenger Transport by Mode

(Unit: million passengers, %)

Modal Split \ Year		1990	1995	2000	2005	2010	2011	2012
Rail	Passenger	644,814	790,381	837,267	950,995	1,060,926	1,118,621	1,152,998
	Share	4.5	5.7	6.2	8.1	8.2	3.8	3.9
Subway	Passenger	1,101,677	1,693,003	2,235,221	2,020,360	2,273,086	2,358,758	2,410,931
	Share	7.6	12.2	16.5	17.1	17.5	8	8.1
Road	Passenger	12,721,877	11,289,507	10,410,577	8,801,839	9,646,404	25,943,079	10,541,921
	Share	87.8	81.8	77	74.6	74.1	88.1	88.2
Marine	Passenger	8,260	8,702	9,702	11,099	14,308	14,266	14,538
	Share	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Aviation	Passenger	11,064	21,009	22,514	17,156	20,216	20,981	21,601
	Share	0.1	0.2	0.2	0.1	0.2	0.1	0.1

Source: Statistical Yearbook of MOLIT, Ministry of Land, Infrastructure and Transport, 2013

There was a fivefold increase in vehicle registration from 3,390 thousand in 1990 to 18,870 thousand in 2012, and a sevenfold increase in the number of passenger cars from 2,070 thousand in 1990 to 14,580 thousand in 2012 (Table 1.6.). The number of vehicles increased as the economy and incomes grew.

2) Travel by road refers to buses (highway, urban, suburban, charter) and taxis combined. In 2011, passenger cars were included; but they are not yet included for 2012, because the data is still being collected.

Table 1.6. Vehicle Registration

(Unit: thousand vehicles)

Year / Vehicle	1990	1995	2000	2005	2010	2011	2012
Number of Registration	3,390	8,470	12,060	15,400	17,940	18,440	18,870
Passenger Car	2,070	6,010	8,080	11,120	13,630	14,140	14,580
Van	380	610	1,430	1,120	1,050	1,020	990
Frieght Truck	920	1,820	2,510	3,100	3,200	3,230	3,240
Special Vehicle	12	33	37	48	56	59	63

Source: Vehicle Registration, Ministry of Land, Infrastructure and Transport, 2013

According to vehicle registration statistics, between 2000 and 2012, the number of gasoline, diesel, and LPG vehicles increased from 1,831 thousand to 3,637 thousand, from 3,594 thousand to 7,002 thousand, and from 1,214 thousand to 2,415 thousand, respectively (Table 1.7.).

Table 1.7. Vehicle Registration by Fuel

(Unit: thousand vehicles)

Year / Fuel	2000	2005	2010	2011	2012
Total	12,059 (100%)	15,395 (100%)	17,941 (100%)	18,437 (100%)	18,870 (100%)
Gasoline	1,831 (15.2%)	1,576 (10.2%)	3,354 (18.7%)	3,556 (19.3%)	3,637 (19.3%)
Diesel	3,594 (29.8%)	5,650 (36.7%)	6,483 (36.1%)	6,705 (36.4%)	7,002 (37.1%)
LPG	1,214 (10.1%)	1,890 (12.3%)	2,444 (13.6%)	2,429 (13.2%)	2,415 (12.8%)
Kerosene	0.12 (0.0%)	0.044 (0.0%)	0.01 (0.0%)	0.006 (0.0%)	0.004 (0.0%)
Electricity	0.006 (0.0%)	0.005 (0.0%)	0.066 (0.0%)	0.344 (0.0%)	0.86 (0.0%)
Alcohol	0.012 (0.0%)	0.025 (0.0%)	0.001 (0.0%)	0.001 (0.0%)	0.001 (0.0%)
Leaded Gasoline	0.147 (0.0%)	0.382 (0.0%)	0.34 (0.0%)	0.332 (0.0%)	0.3 (0.0%)
Unleaded Gasoline	5,383 (44.7%)	6,223 (40.4%)	5,553 (31.0%)	5,614 (30.4%)	5,639 (29.9%)
Other	37 (0.3%)	56 (0.4%)	107 (0.6%)	132 (0.7%)	176 (0.9%)

Source: Vehicle Registration, Ministry of Land, Infrastructure and Transport, 2013

1.6. Building and urban structure

Korea's national economic development plan—first implemented in the early 1960s—led to rapid urbanization with limited capital and resources focused on urban areas. In 2010, the total number of residential houses was estimated at 14,670 thousand across the country, including 8,580 thousand apartments (58.4%), 4,090 thousand detached houses (27.9%), 1,310 thousand multi-family units (9.0%), and 540 thousand row houses (3.7%) (Figure 1.1.).

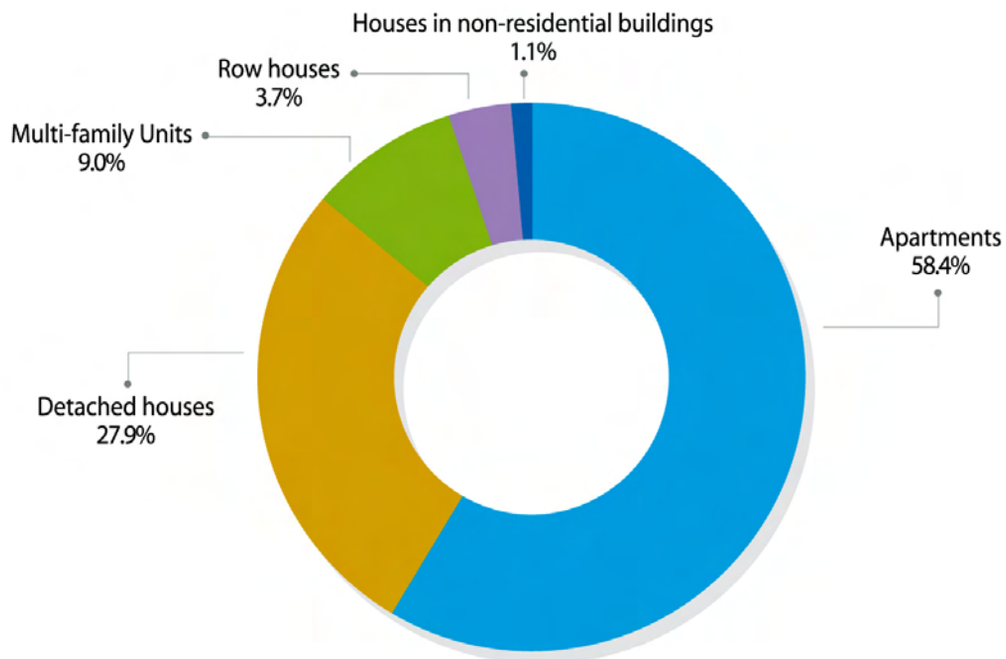

Figure 1.1. Residential house by type

Source: 2010 Population and Housing Census - Complete Survey Results, Statistics Korea, 2010

1.7. Agriculture and forestry

Agricultural land (17,300km²) in Korea amounted to 17.3% of the total land area (100,266km²) as of 2012. From 1990 to 2012, urbanization led to changes in land use, and agricultural land gradually decreased. The total for all agricultural land was 1,730 thousand hectares (ha). Rice cropland represented 966 thousand ha (55.8%) while various crops represented 764 thousand ha (44.2%) (Table 1.8.).

Table 1.8. Use of Agricultural Land

(Unit: thousand ha)

Year / Agricultural Land	1990	1995	2000	2005	2010	2011	2012
Total Agricultural Land	2,108	1,985	1,889	1,824	1,715	1,698	1,730
Rice Cropland	1,345	1,205	1,149	1,105	984	960	966
Crop-yield	763	780	740	719	731	738	764

Source: Agricultural Infrastructure Improvement Statistics Survey, Korea Rural Community Corporation, 2012

Forests in Korea comprised 6,369 thousand ha as of 2010[3], accounting for about 63.5% of the total land area. Of the total forest land, 4,338 thousand ha (68.1%) were privately owned; 488 thousand ha (7.7%) were publicly owned; and 1,543 thousand ha (24.2%) were government owned (Table 1.9.).

Table 1.9. Forest land and Growing Stock

(Unit: ten million m³, thousand ha)

		1990	1995	2000	2005	2010
Total	Growing stock	24.8	30.9	40.8	50.6	80.0
	Forest land	6,476	6,452	6,422	6,394	6,369
Government owned Forest	Growing stock	8.5	10.1	12.6	15.3	22.9
	Forest land	1,346	1,393	1,433	1,484	1,543
Publicly owned forest	Growing stock	1.8	2.2	3.1	4	6
	Forest land	489	492	493	489	488
Privately owned forest	Growing stock	14.5	18.5	25	31.3	51.1
	Forest land	4,625	4,567	4,496	4,420	4,338

Source: Basic Forest Statistics, Korea Forest Service, 2010

3) In accordance with changes in the data collection method for growing stock, the regular interval changed into 5 years—the same as the National Forest Inventory since 2010 (the latest data will be available in June 2016).

1.8. Waste

Industrialization and urbanization led to mass production and consumption, resulting in wide spread material prosperity. At the same time, however, these changes created environmental problems. From an environmental perspective, the amount of waste generated has rapidly increased and made waste treatment more difficult. In order to resolve waste problems more efficiently, Korea has sought to implement socio-economic changes and build a sustainable resource-recycling society.

According to waste generation statistics, households in Korea produced 48 thousand tons per day in 1995. By 2012, this number had remained largely the same with households producing 49 thousand tons per day. Commercial and industrial waste, however, increased by 1.5 fold in these years from 96 thousand tons per day in 1995 to 146 thousand tons per day in 2012 (Table 1.10.).

Table 1.10. National Waste Generation

(Unit: thousand tons/day)

Year / Waste	1990	1995	2000	2005	2010	2011	2012
Total	84 (100%)	144 (100%)	227 (100%)	296 (100%)	365 (100%)	373 (100%)	382 (100%)
Household waste	–	48 (33.3%)	47 (20.7%)	49 (16.5%)	49 (13.4%)	49 (13.1%)	49 (12.8%)
Commercial & Industrial waste	–	96 (66.6%)	101 (44.5%)	112 (37.8%)	138 (37.8%)	138 (37.0%)	146 (38.2%)
Construction waste	–	–	79 (34.8%)	135 (45.6%)	178 (48.8%)	186 (49.9%)	187 (49.0%)

Source: Ministry of Environment and Korea Environment Corporation, 2013

However, The amount of per capita household waste gradually decreased from 1.07kg per day per capita in 1995 to 0.95kg per day per capita in 2012 due to the enforcement of the volume-based waste fee system (implemented in January 1995) (Table 1.11.).

Table 1.11. Per Capita Household Waste Generation

(Unit: kg/day/capita)

	1995	2000	2005	2010	2011	2012
Per capita household waste	1.07	0.98	0.99	0.96	0.95	0.95

Source: National Waste Generation and Disposal, Ministry of Environment, 2013

Chapter 2

NATIONAL GREENHOUSE GAS INVENTORY

Chapter 2. NATIONAL GREENHOUSE GAS INVENTORY

2.1. National Greenhouse Gas Inventory System

2.1.1. National Implementing Entities

The Greenhouse Gas Inventory & Research Center of Korea (GIR) has been tasked with managing the preparation of the national greenhouse gas (GHG) inventory under the *Framework Act on Low Carbon and Green Growth* enacted in 2010.

The key functions of GIR for national GHG inventory are to establish and publish a *National GHG Inventory Management Plan*; to provide the *Guideline for Measurement, Reporting and Verification of national GHG inventory* (MRV[4] Guideline); to verify and decide country-specific emission factors and removal factors; and to manage and operate a National GHG Management System. The National GHG Management System consists of the National GHG Inventory Management Committee (Management Committee), the National GHG Working Group (Working Group), and National GHG Technical Group (Technical Group).

The Management Committee, chaired by the Vice-Minister of Environment, is composed of approximately 15 external experts and government officials (above director-general level) from relevant ministries. Together, they play a critical role in making decisions for the national GHG inventory (see Figure 2.1.). The Working Group, chaired by the president of the GIR, is composed of director-level government authorities from relevant ministries. These officials review final drafts of national GHG inventory and country-specific emission factors and removal factors. The Technical Group is made up of external experts who conduct technical reviews of the national GHG inventory and country-specific emission factors and removal factors. To enhance transparency and the accuracy of the national GHG inventory, Korea separates measurement and verification for the national GHG inventory and operates a step-by-step verification system.

4) MRV : Measurement, Reporting, and Verification

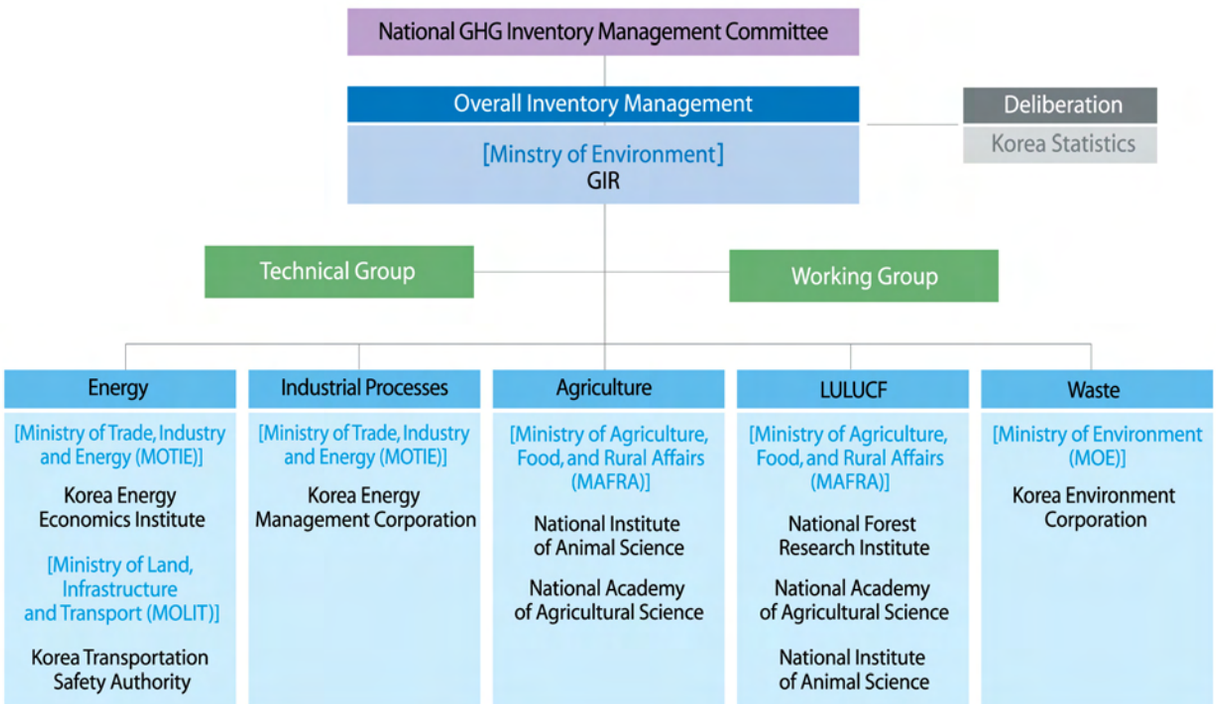

Figure 2.1. National GHG Inventory Arrangement

2.1.1. Process of National Greenhouse Gas Inventory Preparation

《Measurement and Reporting》

As a first step for preparing the national GHG inventory, GIR provides relevant ministries[5] with the MRV Guideline for the National Inventory Report (NIR) and Common Reporting Format (CRF). Every year, GIR revises and improves the previous year's MRV Guideline by analyzing verification results derived from the preparation of NIR and CRF for each sector in the previous year. Thereafter, the Management Committee reviews and approves the amended MRV Guideline, which is then distributed to the relevant ministries responsible for GHG inventory management in each sector by the end of February. The relevant ministries designate an agency[6] in each sector to prepare

5) Relevant ministries: Ministry of Industry, Trade and Energy, Ministry of Land, Infrastructure and Transport, Ministry of Agriculture, Food and Rural Affairs, Ministry of Environment

6) Agencies in each sector: Korea Energy Economics Institute, Korea Transportation Safety Authority, Korea Energy Management Corporation, National Academy of Agricultural Science, National Institute of Animal Science, National Forestry Research Institute, Korea Environmental Corporation

drafts of sectoral NIR and CRF for their part of the GHG inventory in accordance with the approved MRV Guideline. After each relevant ministry reviews sectoral NIR and CRF drafts, the relevant ministries submit the inventory documents prepared by the agencies to GIR each year by June 30. The inventory documents include activity data and expert judgment used in the preparation of the draft, explanatory statements on recalculations data and not-estimated categories on a year-by-year basis, and Quality Assurance/Quality Control reports.

《Verification》

From July to the end of August, GIR conducts an internal review to verify the drafts of sectoral NIR and CRF submitted by relevant ministries. If necessary, the GIR may require an external review with third-party experts. In such a case, additional data are needed for an intensive internal or external review. The GIR, as a result, may ask each relevant ministry for additional data needed to complete the verification process. After completing this process, the GIR prepares a verification report based on the verification results.

《Deliberation and Approval》

By early September each year, relevant ministries in each sector submit the final version of their NIR and CRF to the GIR after revising and improving their documents in cooperation with the agencies. GIR collects the final versions of sectoral NIR and CRF and prepares a final draft of the national GHG inventory, which is reviewed by a Technical Group and Working Group. The Management Committee then reviews and approves the final draft of the national GHG inventory by the end of October. Finally, the GIR publishes the approved version of the national GHG inventory and the annual National Inventory Report.

Table 2.1. National GHG Inventory Measurement, Reporting, and Verification (MRV) Process

Phase		Responsible Entities	Description	Date
Measurement · Reporting	Revision of MRV Guidelines	GIR	• Preparing a revised version of MRV Guidelines	January
	Discussion and approval of the revisions	GIR (Working Group, Management Committee)	• Discussing and approving the revisions made in the MRV Guidelines	February
	Announcement of the annual MRV Guidelines	GIR → Relevant ministries	• Distributing the MRV Guidelines	February
	Sectoral measurement and reporting	Agencies in each sector→ Relevant ministries → GIR	• Submission of sectoral NIR and CRF • Conducting QA/QC activities and submitting the result report	March–June
Verification	Internal/external verification	GIR	• Verification of the drafts of sectoral NIR, CRF • Preparing the final draft of the NIR and CRF	July–August
Deliberation · Approval · Publication	Technical review of Technical Group	GIR (Technical Group)	• Conducting technical reviews of data used for calculation of national GHG inventory • Documenting verification and review results in a verification report	September
	Working Group Review	GIR (Working Group)	• Reviewing the final draft of national GHG inventory • Discussing agendas related to quality improvements in the national GHG inventory	October
	Final review and approval	GIR (Management Committee)	• Approving the official version of the annual national GHG inventory	
	Publication	GIR	• Publishing and distributing the national GHG inventory to the public	November

2.2. Overview of the National Greenhouse Gas Inventory

2.2.1. Greenhouse Gases Covered

The National GHG Inventory is prepared by estimating the emission and removal of six direct GHGs[7] designated by the Kyoto Protocol.[8] These include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrochlorofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). In this report, GHG emissions are estimated in units of tonne carbon dioxide equivalent (CO_2eq.) using Global Warming Potentials (GWPs)[9] values.

2.2.2. Sectors and Years Covered

The National GHG Inventory details national GHG emissions in energy, industrial processes, agriculture, LULUCF (land use, land-use change and forestry), and waste sectors in accordance with the Intergovernmental Panel on Climate Change's Guidelines (IPCC GL)[10] from 1990 to 2012.

2.2.3. National Greenhouse Gas Emission Trends

Total GHG emissions in Korea in 2012[11] were 688.3 million tons of CO_2eq. (excluding LULUCF). This represented a 132.9% increase from the 1990 level of 295.5 million tons of CO_2eq. and a 0.4% increase from the 2011 level of 685.7 million tons of CO_2eq. Net GHG emissions[12] in 2012 were 637.4 million tons of CO_2eq. (including

7) While direct greenhouse gases lead directly to greenhouse effects, indirect greenhouse gases are combined with other substances and converted into GHG. Indirect GHG emissions are not taken into account in the national GHG inventory of Korea.
8) The Kyoto Protocol—the revised version of the UN Framework for the Convention on Climate Change adopted in Kyoto, Japan in 1997—prescribed reduction targets for Annex I Parties. The Government of Korea ratified this protocol in December 2012.
9) Global-warming potential is a relative measure of how much heat GHG traps in the atmosphere. It compares the amount of heat trapped by a certain mass of the gas in question to the amount of heat trapped by a similar mass of carbon dioxide. 100-year GWPs used in the IPCC's Second Assessment Report was applied in the inventory.
10) The Use of Solvents and Other Products (CRF Sector 3) in the 1996 IPCC GL is excluded in this national GHG inventory due to the lack of activity data.
11) Gross GHG emissions mean the amount of GHG emissions from all other sectors than LULUCF.

LULUCF). This represented a 144.1% increase from the 1990 level of 261.1 million tons of CO_2eq. and a 0.5% increase from the 2011 level of 634.5 million tons of CO_2eq. GHG Emission trends from 1990 to 1997 show an annual increase of over 5% per year. Emissions in 1998 declined significantly due to the East Asian economic crisis but grew exponentially thereafter as the regional economy stabilized and experienced renewed growth (Figure 2.2., Table 2.2.).

GHG emissions in 2012 from the energy sector were 600.3 million tons of CO_2eq., accounting for 87.2% of total emissions. This represented a 148.6% increase from the 1990 level and a 0.4% increase from the 2011 level. Emissions from the industrial processes sector were 51.3 million tons of CO_2eq., accounting for 7.4% of total emissions in 2012. This represented a 151.7% increase from the 1990 level and a 0.8% decrease from the 2011 level. The emissions from the agriculture sector were 22.0 million tons of CO_2eq., accounting for 3.2% of total emissions in 2012. This represented a 7.4% decrease from the 1990 level and a 0.6% increase from the 2011 level. Lastly, emissions from the waste sector were 14.8 million tons of CO_2eq., accounting for 2.2% of total emissions in 2012. This represented a 49.4% increase from the 1990 level and a 1.6% increase from the 2011 level.

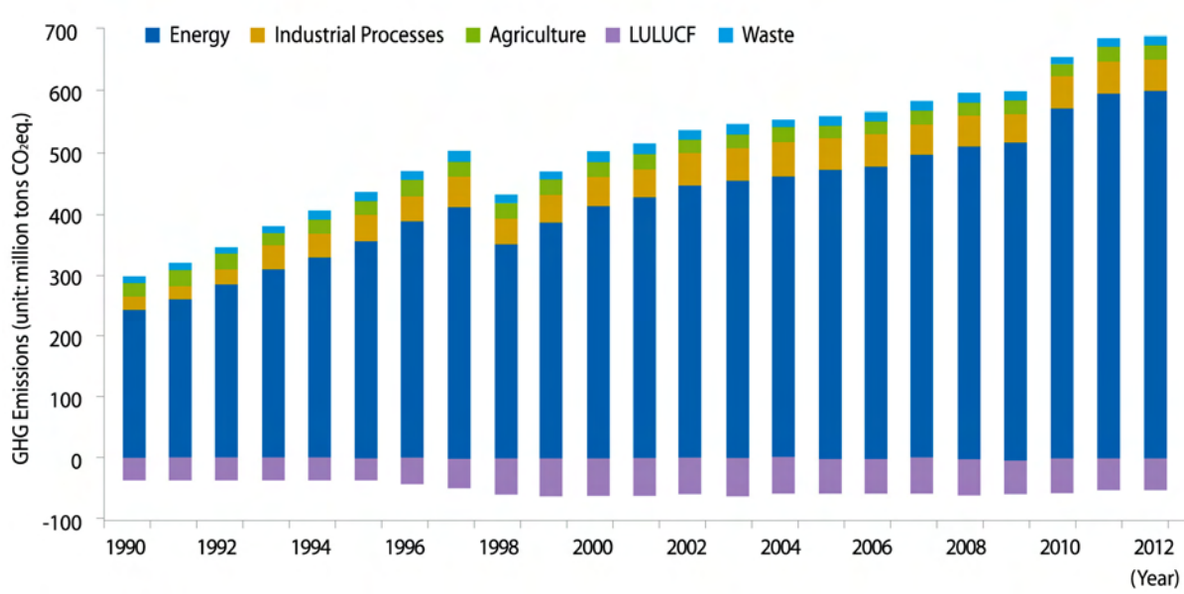

Figure 2.2. National Greenhouse Gas Emissions Trends from 1990 to 2012

12) Net emissions mean the amount of GHG emissions including removals of LULUCF.

Table 2.2. Greenhouse Gas Emissions by Sector from 1990 to 2012

(Unit: Million Tons of CO_2eq.)

Sector	GHG Emissions					Emission Changes of 2012 compared to 1990 levels	Emission Changes of 2012 compared to 2011 levels
	1990	2000	2010	2011	2012		
1. Energy	241.5	411.9	568.6	597.6	600.3	148.6%	0.4%
2. Industrial Processes	20.4	49.6	52.4	51.7	51.3	151.7%	−0.8%
3. Agriculture	23.8	23.7	22.0	21.9	22.0	−7.4%	0.6%
4. LULUCF	−34.4	−58.9	−54.9	−51.3	−50.9	48.0%	−0.7%
5. Waste	9.9	17.8	14.1	14.6	14.8	49.4%	1.6%
Total GHG Emissions	295.5	503.1	657.1	685.7	688.3	132.9%	0.4%
Net GHG Emissions	261.1	444.1	602.3	634.5	637.4	144.1%	0.5%

Chapter 3

MITIGATION ACTIONS AND EFFECTS

Chapter 3. MITIGATION ACTIONS AND EFFECTS

3.1. National Reduction Targets and Roadmap

After the declaration of the Low Carbon, Green Growth vision in 2008, Korea—based on scientific and objective analysis in November 2009—officially announced a mid-term national GHG reduction target 30% lower than BAU level by 2020. Since then, the government has determined reduction targets by sector and year through a joint task force led by GIR and relevant ministries in July 2011. According to reduction targets set for 2020, the sector with the highest reduction rate will be transport (34.3%), followed by building (26.9%), energy transformation (26.7%), and industry (18.2%) (Figure 3.1.). According to the emissions pathway by year, GHG emissions in Korea will reach their peak in 2014 and begin to decline by 2015, resulting in the decoupling of GHG emissions from economic growth (Figure 3.2.).

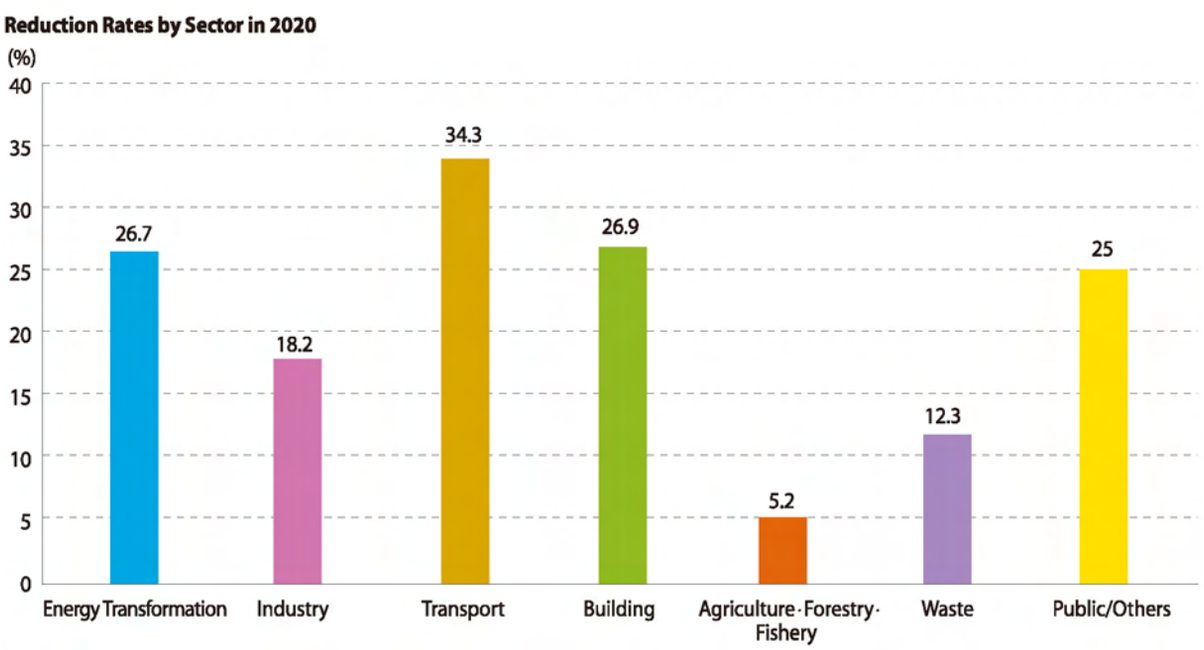

Figure 3.1. GHG Reduction Rates by Sector in 2020

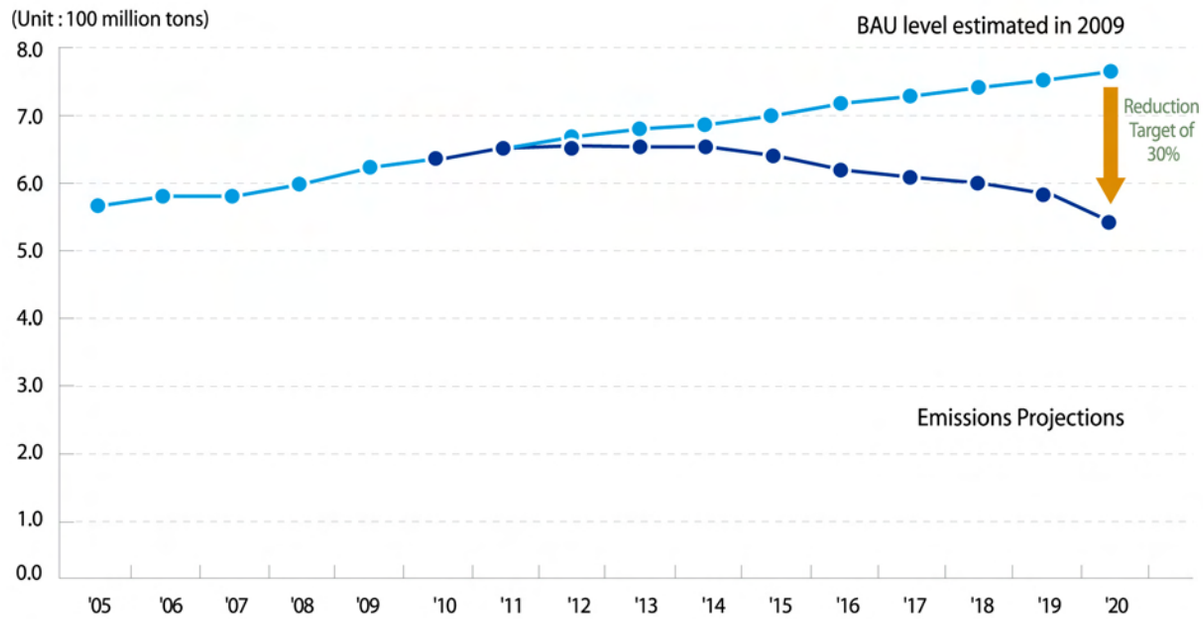

Figure 3.2. GHG Reduction Pathways by Year

The emission reduction targets by sector and year set in 2011 are significant in terms of suggesting specific goals based on detailed data and modeling analyses. Still, there is not sufficient information on emission reduction action plans for each sector. In order to implement the pledge to reduce GHG emissions, Korea developed a Roadmap to accomplish the National Greenhouse Gas Reduction Targets in January 2014.

The Roadmap presents detailed emission reduction policies and measures for each sector—including industry, building, and transport—to achieve planned reduction targets (Figure 3.3). Particularly, the Roadmap offers more than 80 mitigation measures with their target and mitigation potentials for 2017 and 2020. If these mitigation measures for each sector are successfully implemented, 119 million tons of CO_2eq. and 233 million tons of CO_2eq. will be reduced across the country by 2017 and 2020, respectively. This amount accounts for 16.2% and 30.0% of BAU presented in the Roadmap in 2014.

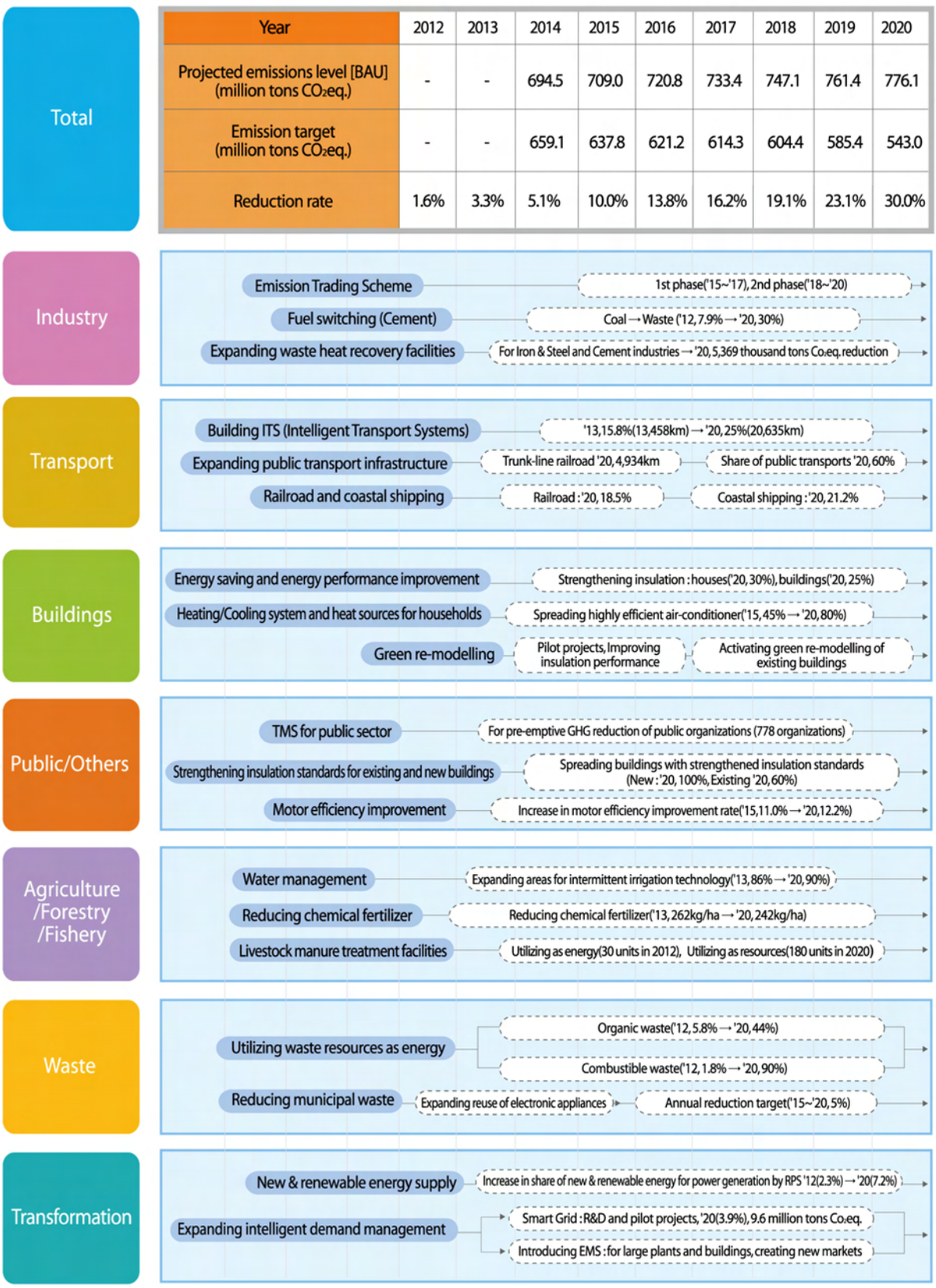

Figure 3.3. Emission Reduction Action Plans by Sector (2014-2020)

The Roadmap also includes strategies such as (1) a market-friendly emission reduction system; (2) the application of new technologies; (3) the creation of jobs and new markets; and (4) low-carbon lifestyles and social practices. The followings are the details of these strategies. First, market-friendly GHG reduction will be implemented through the Emissions Trading Scheme; the management of energy demands; capacity building; and supporting plans for small & medium businesses to reduce emissions. Second, long-term R&D strategies will be developed, alongside core technologies, for reducing emissions and strenghthening the capacity of the domestic science and technology fields to tackle climate change. Third, new jobs will be created in the GHG mitigation sector. At the same time, employment will be increased and new businesses will be developed through projects for fostering a specialized workforce. Lastly, GHG mitigation actions in everyday life will be actively carried out through various campaigns and movements.

The Roadmap also provides an evaluation plan for emission reductions that regularly monitors the progress of the reduction measures described above and uses evaluation outcomes to improve the action plans. According to the evaluation plan, relevant ministries should set up detailed implementation plans for each sector annually. Additionally, a supervising institution —such as the Office for Government Policy Coordination—should evaluate the performances of the relevant ministries in revising and implementing their plans.

3.2. Operation of the Greenhouse Gas & Energy Target Management System

Since 2010, Korea has operated the Greenhouse Gas and Energy Target Management System (TMS) to manage businesses that are both large GHG emitters and large energy consumers. The TMS is designed for the systematic management of GHG emissions. Specifically, it imposes GHG reduction and energy conservation targets on large businesses not covered by the GHG Emissions Trading Scheme (ETS), which emit GHGs and consume significant amounts of energy. As of 2014, Korea designated business entities that generate GHG emissions more than 50 thousand tons CO_2eq. and consume over 200 TJ of energy annually—or own facilities generating more than 15 thousand tons CO_2eq. and consuming over 80 TJ of energy annually—as controlled entities. Following the announcement of this policy in June 2014, 840 controlled entities are subject to the TMS, of which 315 businesses not covered by the ETS and will be regulated under this system from 2015 onward.

Four government ministries (including the Ministry of Agriculture, Food, and Rural Affairs; the Ministry of Trade, Industry, and Energy; the Ministry of Land, Infrastructure, and Transport; and the Ministry of Environment) will provide oversight for the businesses regulated under the TMS. The Ministry of Agriculture, Food, and Rural Affairs is responsible for the agriculture, forestry, and food sectors; the Ministry of Industry, Trade, and Energy is responsible for the industrial and public electricity generation sectors; the Ministry of Land, Infrastructure, and Transport is responsible for the building and transport sectors; and the Ministry of Environment is responsible for the waste sector. The TMS is operated under the supervision of the Ministry of Environment, which is in charge of overall guidelines and standards for the TMS regulation, the supervision of other relevant ministries, and the appointment of verification agencies.

Table 3.1. Relevant Ministries by Sector under TMS

Sector	Relevant Ministry
Agriculture, Forestry and Food	Ministry of Agriculture, Food and Rural Affairs
Industry and Power	Ministry of Industry, Trade and Energy
Building and Transport	Ministry of Land, Infrastructure and Transport
Waste	Ministry of Environment

The outcome of the TMS regulation in 2012 led to 21.3 million tons CO_2eq. of emission reductions, which accounted for 3.78% of the 2012 total emission projections (563.6 million tons CO_2eq.). This reduction—achieved by 392 of 434 regulated businesses (90.3 percent of the regulated)— was 2.7 times the 2012 national reduction target of 7.95 million tons (1.41% of the 2012 emission projections). The industries that contributed most significantly to this reduction include petrochemical (6.9 million tons CO_2eq.), steel (5.73 million tons CO_2eq.), and semiconductor/display/electrical and electronic industries (5.3 million tons CO_2eq.). Among those, 372 controlled entities surpassed their reduction targets, amounting to 30.05 million tons CO_2eq. These excess of the reduction target can be used as early reduction credits under the ETS that will come into effect in 2015. These credits should comprise less than 3% of total allocated allowances.

Monitoring and reporting of the facility-level GHG emissions is the basis of implement-

ing the TMS regulation. Guidelines for the Operation of the Greenhouse Gas and Energy Target Management System (Ministry of Environment Notification) are established and continuously revised by the Ministry of Environment. The Ministry uses the best available and adequate estimation methodologies, as well as standards for management of emission factors and activity data, in order to establish a world-class GHG measurement, reporting, and verification system. Moreover, the Ministry of Environment has appointed 24 expert agencies with qualified verifiers—who have passed strict certificate examinations—as verification agencies for the third party verification of the GHG emissions and Energy Consumption Statement.

3.3. Adoption of the Emissions Trading Scheme

Korea has taken steps to implement the GHG Emissions Trading Scheme (ETS) as part of its effort to a transition towards a low-carbon, highly efficient industrial structure while achieving the 2020 national reduction targets in an economically feasible manner.

The government has created a legal foundation for the implementation of the system by creating and enforcing *the Act on Allocation and Trading of Greenhouse Gas Emissions Allowances* and *the Enforcement Decree of the Act* in 2012. In 2014, as related subsidiary plans were created—such as the *Master Plan for the Emissions Trading Scheme and the Phase I National Allowances Allocation Plan*—the necessary procedures were implemented to begin the ETS on January 1, 2015.

The ETS is operated under five-year plans, but phase I (2015~2017) and Phase II (2018~2020) will run for three years respectively, considering the early stage of implementation. Among the business entities subject to the TMS, the ETS will be applied to those who generate over 125,000 tons of CO_2eq., or own facilities generating over 25,000 tons of CO_2eq., on the annual average rate of 3 years. In addition, it will be applied to the six GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrochlorofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Aside from direct GHGs, indirect GHG emissions[13] resulting from the use of electricity and heat are also managed through the trading scheme by taking account of the nation's regulating system for electricity prices and the country's

13) Emitting greenhouse gases using electricity or heat supplied by others (10 of Article 2 of the Framework Act on Low Carbon and Green Growth)

need for electricity demand management[14].

The *Phase I National Allowances Allocation Plan* established in September 2014 includes a detailed action plan for the allocation of allowances during Phase I period, such as the total emission cap and allocation criteria. During the Phase I period, the ETS will be applied to all sectors subject to the TMS except for road and railway industries. Consequently, approximately 525 companies are expected to participate, accounting for 68% of national GHG emissions. The total number of allowances during Phase I will be 1,686.5 million KAU[15] (Korean Allowance Unit). Approximately 95% (1,597.7 million KAU) will be allocated before the phase begins (allowances for pre-allocation) while the remaining 5% (88.8 million KAU) will be allocated during the phase (reserves). Allowances for pre-allocation will be 543.2 million KAU for 2015, 532.6 million KAU for 2016, and 521.9 million KAU for 2017, respectively. The reserves will be used for the purpose of market stabilisation and compensation for early emission reductions. The reserves not used during the phase will be discarded and will not be carried over to the next plan period.

Table 3.2. Total Number of Allowances during the Phase I Plan Period of the Korea Emissions Trading Scheme

(Unit : Million Ton KAU)

Total Allowances	1,686.5	
Pre-allocation	1,597.7	543.2 in 2013, 532.6 in 2016, 521.9 in 2017
Reserves	88.8	14.3 for Market Stability, 41.4 for Early Emission Reductions, 33.1 for Others

100% free allocation will be allowed during Phase I to stabilize the scheme, but the ratio of non-free allocation will increase gradually from Phase Ⅱ to ensure the effectiveness of the system. Most allowances will be allocated based on their past emissions (grandfathering). A part of emitting facilities in some sectors (oil refinery, cement, and aircraft) will be allocated considering their historical activity data and efficiency of facilities (benchmarking).

14) 2 of Article 2 of the Act on Allocation and Trading of Greenhouse Gas Emissions Allowances and 10 of Article 2 of the Framework Act on Low Carbon and Green Growth

15) English shorthand for allowances for allowance history management, trade statistics management, and efficient operation of allowances registers, and international connections in the trading market. 1KAU≡1 ton of CO_2eq.

In addition, several flexibility mechanisms—including banking, borrowing, and off-setting—will be allowed to reduce mitigation costs and to secure liquidity in the allowances market. While unlimited carryover of the remaining allowances to the next year will be allowed to provide incentives for mitigation efforts, there will be a quantitative limit[16] on the borrowing of allowances and the use of offsets to ensure the effectiveness of the system. For example, the use of offset can be utilized only for reductions that meet global standards, such as the certification of Certified Emission Reductions (CER) from Clean Development Mechanism (CDM) projects in securing environmental integrity[17]. Accordingly, this has been specified in the *Guidelines for Validity Assessment of Reduction Projects and Certification of Emission Reductions*.

The data used for allocation was based on accumulated greenhouse gas emission reports submitted by controlled entities over the years under TMS. This installation and facility level data has been collected from 2007 until the present. The data is extremely reliable as it has been checked through a third-party verification system and a double-review system in the supervising agency and authority.

3.4. Mitigation Actions by Sector

In November 2009, Korea fixed the national mid-term GHG reduction targets 30% lower than BAU level by 2020. In turn, it also set up specified reduction targets by sector and industry, as well as emission reduction rates for each year.

First, in all sectors, the TMS has been implemented since 2010 to achieve national mid and long-term GHG reduction targets and to reduce energy consumption—especially with large GHG emitters and large energy consumers. In addition, the ETS will be implemented from 2015 onward to set the total GHG emission rates for business entities and to achieve GHG reduction targets through the ETS.

16) Borrowing is only allowed in the next year of the plan period, and the quantitative limit for borrowing is 10% of allowances to be submitted to authorities. The quantitative limit for offsetting is same as that for borrowing.

17) Articles 29 and 30 of the Act on Allocation and Trading of Greenhouse Gas Emissions Allowances

In the energy transformation sector, Korea is preventing GHG emissions by Renewable Portfolio Standard (RPS) mandate and offering subsidies for new and renewable energy power plants. Moreover, it is treating emitted GHGs by encouraging the development of technologies for the capture and storage of CO_2.

In the industry sector, Korea is proposing emission reduction measures for each step of the national energy system, from the establishment of the energy supply and demand plan to energy distribution and usage. In this regard, the Consultation on Energy Use Plan aims to ensure efficient energy consumption by analyzing the impact of businesses on GHG emission during the establishment stage of the plan. In addition, heat and electricity generated from district heating and cooling systems and integrated energy systems of industrial complexes are distributed to a variety of consumers. Since 2011, the Energy-Efficiency Standard & Labelling program has been implemented for this objective.

In the building sector, Green Building Standards Code, Building Energy Efficiency Grade Certification System, and Green Home Performance Evaluation System have been implemented to pursuit comprehensive energy efficiency with buildings' design and operation.

In the transport sector, the Intelligent Transport Systems (ITS) has been established to expand public transport infrastructure and Voluntary Logistics Energy Target Management System has encouraged 140 companies to participate as of 2014. Moreover, the target of automobile fuel economy management has been expanded to reduce GHG emissions by cars.

In the agriculture, forestry, and fishery sectors, Korea has taken actions to reduce GHG emissions from rice farmlands with the water management for rice crops since 2010 and has expanded the Livestock Manure-To-Energy system since 2007.

Finally, in the waste sector, Korea has sought to minimize the generation of municipal and industrial waste since 2008. And it has reduced carbon dioxide and methane emissions by processing combustible and organic waste into energy and by recovering and reusing landfill gases.

Table 3.3. Mitigation Actions and Effects

Sectors affected	Name of mitigation action	GHG (s) affected	Objectives	Description of mitigation actions	Type of instrument	Implementing ministry	Status of implementation	Start year and month of implementation	Performance indicator(s)
All Sectors	Greenhouse gas & energy target management system (GHG & Energy TMS	CO_2 CH_4 N_2O	GHG and energy reduction	o To regulate GHG emissions and the energy consumption of business entities emitting large amounts of GHGs in order to achieve national mid-and long-term GHG reduction targets and to reduce energy consumption	Policy	Ministry of Environment	Implemented	2010.4	The amount of GHG emission reduction
	Emissions Trading Scheme (ETS)	CO_2 CH_4 N_2O	GHG and energy reduction	o To set the total amount of GHG emission permits for each company and to compel it to achieve GHG emission reduction targets through emission permits trading alongside its own GHG reduction efforts.	Policy	Ministry of Environment	Planned	2015	The amount of GHG emission reduction
Energy transformation	New & renewable energy supply expansion and industry fostering	CO_2	Contributing to the creation of new & renewable energy markets by encouraging GHG emission reductions and by creating a stable investment environment where companies can invest in new & renewable energy industries	o To enforce FIT(2002~2011) and RPS(from 2012) in order to require power generation companies possessing more than certain amount of power generation facilities (500 thousand kW) to supply new & renewable energy of more than a certain percentage of the total power generation. o To expand new & renewable energy supplies and create a supply base of newly developed technologies through a project to subsidize a portion of installation costs for new & renewable energy projects, including houses (1 million Green homes), buildings (general supply), regions (regional supply), etc. o To make domestic technical standards for new and renewable energy equipment in compliance with international standards and to bring national standards in line with international standards as a COSD*(designated in 2009) * Cooperation Organization for Standards Development (COSD): the organization is accredited by the Korean Agency for Technology and Standards for its ability to develop KS standards for each specialized sector	Policy	Ministry of Trade, Industry, and Energy	Implemented	Informed separately	Power supplied by New and Renewable Energy (TOE)

Sectors affected	Name of mitigation action	GHG (s) affected	Objectives	Description of mitigation actions	Type of instrument	Implementing ministry	Status of implementation	Start year and month of implementation	Performance indicator(s)
Energy transformation	CO_2capture and treatment	CO_2	Innovative technology development of CO_2 sequestration and treatment	o In accordance with the National CCS comprehensive promotion plan (July 2010, interagency meeting) to develop an innovative technology—to capture CO_2 from large emission sources to compress and transport or store underground or into the marine geological structure, or to convert into useful substances	Technology development	Ministry of Science, ICT and Future planning	Technology development underway	2011	To secure cost-competitive CO_2 Capture technology by 2020
Industry	Energy audit system	CO_2 CH_4 N_2O	Contributing to energy reduction at the national level	o To require businesses consuming more than 2,000 TOE annually to receive energy audit on a periodic basis.	Policy	Ministry of Trade, Industry, and Energy	Implemented	2007.1	-
	Consultation on energy use plan	CO_2 CH_4 N_2O	The realization of a low energy consuming society	o To analyze how the implementation of agreed target projects affects energy supply and demand and GHG emissions as a result of energy consumption, and to create plans for required energy supplies and the rational use of energy and its evaluation.	Policy	Ministry of Trade, Industry, and Energy	Implemented	1991.12	-
	Investment support for energy-efficiency facilities	CO_2 CH_4 N_2O	Promoting an energy-saving facilities supply, and the enhancement of energy reduction and energy use efficiency	o To give long-term loans with low interest rates for investment in energy-saving facilities for energy use rationalization and GHG reduction (such as investment projects and the installation of target management companies).	Policy	Ministry of Trade, Industry, and Energy	Implemented	1980	The amount of Energy Saving (TOE, Tonnage of Oil Equivalent)
	Expansion of energy service company project	CO_2 CH_4 N_2O	Promotion of energy-saving facilities supply, and enhancement of energy reduction and energy use efficiency	o A project to allow energy users in need of technical skills and funding ability to make replacement for energy-saving facilities through contracts with energy service company (ESCO).	Policy	Ministry of Trade, Industry, and Energy	Implemented	1992	-
	Energy-efficiency standard & labelling program	CO_2 CH_4 N_2O	Promotion of high-efficiency products production, technology development and energy-saving products purchase of consumer	o A system to enforce efficiency grade labelling (from 1st to 5th grade) according to energy consumption efficiency (usage) of target products and to prohibit production and sales of products not meeting the lowest consumption efficiency standards	Policy	Ministry of Trade, Industry, and Energy	Implemented	1992	The amount of Energy Saving (TOE)

Sectors affected	Name of mitigation action	GHG (s) affected	Objectives	Description of mitigation actions	Type of instrument	Implementing ministry	Status of implementation	Start year and month of implementation	Performance indicator(s)
Industry	Standby power warning indication system	CO_2 CH_4 N_2O	Promotion of the implementation of standby power reduction function of electronic products and the supply of the products excellent in standby power reduction	o To induce the adoption of power saving mode during standby time and the minimization of standby power and to permit energy saving marks for the products meeting standby power reduction standards and to force the display of warning labels on the products failing to meet the standards.	Policy	Ministry of Trade, Industry, and Energy	Implemented	1999	–
	High-efficiency energy equipments certification system	CO_2 CH_4 N_2O	Promotion of the initial market formation and supply equipments with large energy-saving effects by certifying them as high efficiency equipments and the rise of technical standards of SMEs	o A system for the government to certify the products that meet certain criteria for energy consumption efficiency to promote the development of the technologies for high efficiency products and to expand their supply. The certificate is issued for certified product and the product is displayed with high efficiency energy equipment marks. o Voluntary certification application system	Policy	Ministry of Trade, Industry, and Energy	Implemented	1996	The amount of Energy Saving (TOE))
	Integrated energy system	CO_2 CH_4 N_2O	Proactive response to the energy saving and climate change convention through the expansion of integrated energy supply	o A project to provide a large number of users with energy (heat and/or electricity) produced in the energy production facilities composed one or more of combined heat and power plant, heat-only boilers, and resource recovery facilities through district heating and cooling businesses and integrated energy systems of industry complexes.	Policy	Ministry of Trade, Industry, and Energy	Implemented	1985	–
	Voluntary emission reduction registration program	CO_2 CH_4 N_2O	Strengthening of SMEs' competitiveness and induction of early reduction	o A program to register the planned amounts after evaluating the domestic greenhouse gas reduction projects in accordance with objective assessment procedures and to recognize the reduction results during the validity period (5 years) of the program through the certification and inspection. o Target : Businesses with yearly greenhouse gas emissions reduction of more than 100t of CO_2 * Reduction businesses, of which starting point (a time when actual GHG reduction occurs) is within 1 year from the date of application. * Key registration target businesses : "Energy use rationalization businesses", "New & renewable energy development businesses", "Other reduction businesses recognized by the government"	Policy	Ministry of Trade, Industry, and Energy	Implemented	2005	–

Sectors affected	Name of mitigation action	GHG (s) affected	Objectives	Description of mitigation actions	Type of instrument	Implementing ministry	Status of implementation	Start year and month of implementation	Performance indicator(s)
Transport	Increase in transport share rate of coast shipping	CO_2 CH_4 N_2O	Expansion of public transport infrastructure and the building of a low carbon logistics system	o To activate the Modal Shift from road to railroad and coast shipping in order to increase the transport share rate of coast shipping from 20.7% (2008) to 21.2% (2020) * The First Sustainable National Transport and Logistics Master Plan (June. 2011, Ministry of Land, Transport and Maritime Affairs)	Expansion of freight transport	Ministry of Oceans and Fisheries	Implemented	2010	Freight share rate of coast shipping (%)
	Improvement in ship energy efficiency	CO_2 NO_X, etc.	Development of testing and a certification system for green ship technology	o To increase the supply of new & renewable energy including solar, wind, and hydropower in the shipping sector : 0% (2007) → 5% (2020) * The First Sustainable National Transport and Logistics Master Plan (June. 2011, Ministry of Land, Transport and Maritime Affairs)	New & renewable energy supply	Ministry of Oceans and Fisheries	Implemented	2012	Achievement rate of target development(%)
	Strengthening of automobile GHG emission standards	CO_2	Automobile GHG emission reduction	o To set up and strengthen average greenhouse gas emissions and fuel economy standards for automobiles and to expand target models in order to gradually increase greenhouse gas reduction. o Frist stage (2012~2015): car and MPV (10 passengers or less), 140g/㎞ Second stage (draft) (2016~2020): car and MPV, 97g/km ; van (3.5 tons or less), 166g/km	GHG standard setting	Ministry of Environment	Implemented	2012.1~	The amount of GHG emission reduction
	Enhancement of traffic demand management and traffic operation efficiency	CO_2 CH_4 N_2O	Building a low-carbon intelligent transport systems (ITS) and promoting green transport	o Establishment of low carbon ITS - Expansion of intelligent transport systems (ITS) to the national main roads highways - Expansion of Interstate Bus information system - Installation of roundabouts preventing traffic accidents and reducing delays traffic and congestion at the same time o Vitalization of green transport systems - Introduction of main road express bus system, Promotion of bicycle use through public bicycle system - The selection and operation of a public transport -only area - Expansion of citywide railway service and building high-speed rail networks - Expansion of eco-driving education to save energy and to reduce automobile GHG emissions	Policy	Ministry of Land, Infrastructure and Transport, Ministry of Security and Public Administration	Implemented	2007	The rate of ITS establishment (%)

Sectors affected	Name of mitigation action	GHG (s) affected	Objectives	Description of mitigation actions	Type of instrument	Implementing ministry	Status of implementation	Start year and month of implementation	Performance indicator(s)
Transport	Low carbon logistics system building	CO_2 CH_4	Building a low cost & high efficiency of green logistics system	o Enhancement of GHG reduction activities in the logistics system – Encouraging more companies to participate in the Voluntary Logistics Energy Target Management system – The number of participant companies in the Voluntary Logistics Energy Target Management system as of 2014 : 140 – Establishing guidline for the designation of well –managed companies practicing Green Logistics – Expanding the recognition of well–managed companies practicing Green Logistics – The number of companies recognized for well –managed practices with Green Logistics as of 2014: 4 – Vitalization of Modal Shift from road freight into rail freight	Policy	Ministry of Land, Infrastructure and Transport	Implemented	2010	The number of companies designated as the well–managed practices for the Green Logistics
Building	Building energy efficiency grade certification system	CO_2 CH_4 N_2O	Promotion of the buildings excellent in energy performance and enhancement of energy use efficiency in the building sector	o To assess the amount of energy required for building operations—including heating, cooling, hot water, etc. —with design documents and to give a grade to each building from 1+++ to 7 (10 grades) according to its energy performance for certification. – A certificate (preliminary certification and certification) is issued after the certification evaluation by a certification authority and the certification results are managed in the operating agency.	Policy	Ministry of Land, Infrastructure and Transport, Ministry of Trade, Industry, and Energy	Implemented	2001.6	The number of certificate issued
	Green Home Performance Evaluation system	CO_2 CH_4 N_2O	Expansion of Green Buildings' supply	o To comply with construction and performance standards of energy–saving Green Buildings for climate change response and low carbon green growth. – Mandatory submission of Green Home performance reports and supporting documents for the relevant authority (head of local government) at the time of application for project approval for apartment buildings with more than 30 units, and project approval decisions in accordance with the opinion of energy–related professional organization.	Policy	Ministry of Land, Infrastructure and Transport, Ministry of Trade, Industry, and Energy	Implemented	2009.10~	The supply rate of Green Building (%)

Sectors affected	Name of mitigation action	GHG (s) affected	Objectives	Description of mitigation actions	Type of instrument	Implementing ministry	Status of implementation	Start year and month of implementation	Performance indicator(s)
Agriculture, forestry and fishery	Enlarging areas of intermittent irrigation in rice cropland	CH_4	GHG reductions through the management of water supplies in rice cropland	o GHG reductions in rice cropland through development and distribution of related technologies to manage water more efficiently in rice cropland	Policy	Ministry of Agriculture, Food and Rural affairs	Implemented	2010	The ratio of intermittent irrigation area(%)
	Reduction in chemical fertilizer usage	N_2O	GHG reductions by reducing the use of chemical fertilizers	o Reducing chemical fertilizer usage by supporting the use of organic fertilizers and soil conditioners	Policy	Ministry of Agriculture, Food and Rural affairs	Implemented	2000	The amount of chemical fertilizer used (kg/ha)
	Expansion of livestock manure treatment facility	CH_4	GHG reductions by using livestock manure as resource	o GHG reductions by expanding facilities with livestock manure treatment to generate more efficient levels of energy and resources	Policy	Ministry of Agriculture, Food and Rural affairs	Implemented	2007	The number of livestock manure treatment facilities launched
	Expansion of high-quality forage cultivation	CH_4	GHG reductions by increasing provision of high-quality forage to livestock	o GHG reductions through improved enteric fermentation of animals by cultivating high-quality forage and increasing provision to livestock	Policy	Ministry of Agriculture, Food and Rural affairs	Implemented	1998	The supply rate of high-quality forage (thousand ton)
	Expansion of new & enewable energy facility	CO_2 CH_4 N_2O	Reduction of GHG from controlled agriculture through expansion of new & renewable energy facilities	o To reduce fossil fuel consumptions through expanded supplies of new & renewable energy facilities.	Policy	Ministry of Agriculture, Food and Rural Affairs	Implemented	2010	The area of renewable energy facilities supported (ha)
	Expansion of energy reduction facilities supply	CO_2 CH_4 N_2O	GHG reduction through expanded supply of energy reduction facilities for greenhouse farming	o To reduce fossil fuel consumptions through expanded supplies of energy reduction facilities for controlled agriculture.	Policy	Ministry of Agriculture, Food and Rural Affairs	Implemented	2009	The area of energy reduction facilities supported (ha)
	Afforestation	CO_2	Expansion of carbon sinks in the forestry sector	o To promote a new afforestation project on the idle land, including marginal farmlands, used village land, and deforested land for the expansion of carbon sinks.	Policy	Korea Forest Service	Implemented	2007	The area of afforestation
	National long-term measures for forest fire prevention	CO_2	Capacity building for improved responses to forest fires	o To establish long-term measures every five years for an efficient and systematic way to prevent forest fires	Policy	Korea Forest Service	Implemented	2012~2016	The area damaged by forest fire compared to dry days

Sectors affected	Name of mitigation action	GHG (s) affected	Objectives	Description of mitigation actions	Type of instrument	Implementing ministry	Status of implementation	Start year and month of implementation	Performance indicator(s)
Agriculture, forestry and fishery	Creation of city forest	CO_2	Expansion of carbon sinks through the creation of urban forest and street trees, etc	o Central government and local governments continue to create urban forests with available budgets and motivate the participation of citizens, organizations, and businesses to improve the quality of urban life and the expansion of carbon sinks	Policy	Korea Forest Service	Implemented	2003	The area of city forest and the length of street trees created by the project
	Forest carbon offset scheme	CO_2	Support of voluntary CO_2 reduction in private sector	o A scheme established according to the act on the management and improvement of carbon sink(in 2013) to support voluntary CO_2 emission reduction efforts in private sector by using carbon sinks, such as afforestation, forest management, wood products use, forestry biomass energy use, etc.	Policy	Korea Forest Service	Implemented	2013	The number of forest carbon offset registered
Wastes	Reduction of municipal wastes	CO_2 CH_4	Minimization of municipal waste	o To create a resource recycling society through the implementation of municipal waste reduction policy.	Policy	Ministry of Environment	Implemented	2008	The reduction rate of municipal wastes (%)
	Reduction of industrial wastes	CO_2 CH_4	Minimization of industrial waste	o Continuous reduction in industrial waste generation intensity – 52.4 kg/ton (2010) → 49.8 kg/ton (2014) → 45 kg/ton (2020)	Policy	Ministry of Environment	Implemented	2008	Industrial waste generation intensity (kg/ton)
	Waste wood recycling	CO_2 CH_4	GHG reduction through waste wood recycling	o Promotion of waste wood recycling – Increase of waste wood recycling rate from 57% 2011 to 90% in 2020.	Policy	Ministry of Environment	Implemented	2008	The recycling rate of waste wood (%)
	Landfill gas recovery	CO_2 CH_4	GHG reductions through increased landfill gas recovery rates	o Increase in landfill gas recovery and power generation – Increase from 84% in 2010 to 90% in 2020	Policy	Ministry of Environment	Implemented	2010	The rate of landfill gas recovery and power generation (%)
	Utilization of organic waste as energy	CO_2 CH_4	GHG reductions by increasing the utilization of organic waste as energy	o Increase in energy conversion rate of organic waste – Increase from 5.8% in 2012 to 44% in 2020	Policy	Ministry of Environment	Implemented	2008	The utilization rate of organic waste as energy (%)
	Utilization of combustible waste as energy	CO_4 CH_4	GHG reductions by increasing the utilization of combustible waste as energy	o Increase in energy conversion rate of combustible waste – Increase from 1.8% in 2012 to 90% in 2020	Policy	Ministry of Environment	Implemented	2012	The utilization rate of combustible wastes as energy(%)

Chapter 4

NEED OF FINANCE, TECHNOLOGY, AND CAPACITY BUILDING AND ASSISTANCE STATUS

Chapter 4. NEED OF FINANCE, TECHNOLOGY, AND CAPACITY BUILDING AND ASSISTANCE STATUS

4.1. Need of Finance and Assistance Status

4.1.1. Financial Assistance through Multilateral Institutions

The Official Development Aid (ODA) of the international community is divided into bilateral cooperation and multilateral cooperation by channel: multilateral cooperation refers to indirect support for recipient countries through subscribed capital and contributions to international development agencies. For example, Korea—in pursuit of active support for climate change response efforts in developing countries—provides international organizations and associations related to climate change, such as Climate Investment Funds (CIF), United Nations Framework Convention on Climate Change (UNFCCC), and Asia-Pacific Network for Global Change Research (APN), with funds, technology, manpower, etc. Donations and grants are the financial assistance mostly frequently provided. The total sum of donations has increased by 80.8% from 13,353 million KRW in 2010 to 24,145 million KRW in 2013 (Table 4.1.).

4.1.2. Financial Assistance through Bilateral, Regional, and Other Channels

Bilateral aid means that donor countries give direct support to recipient countries through providing funds and various resources. As shown in Table 4-2, Korea became involved in bilateral aid projects in 2010. Since then, the Korean government has provided financial assistance through concessional loans and donations for developing countries such as Cambodia, Indonesia, Vietnam, etc. This assistance has sought to aid those countries' power industries and agriculture and livestock sectors and support their ability to consider and adopt climate change mitigation practices. This total financial assistance has increased 39.0% from 146,652 million KRW in 2010 to 203,869 million KRW in 2013 (Table 4.2.).

Table 4.1. Financial Assistance via Multilateral Institutions (2010-2013)

Year	Sector	Multilateral institutions	Total				Status	Funding sources	Financial instruments	Support type
			General		Climate-related					
			million KRW	US Dollar	million KRW	US Dollar				
2010	All Sectors	CIF (Climate Investment Funds)	-	-	3,690	3,183,779	Completed	ODA	Donation	Mitigation & Adaptation
		UNFCCC (United Nations Framework Convention on Climate Change)	-	-	556	481,219 (EUR 370,667)	Completed	ODA	Donation	Mitigation & Adaptation
		GEF (Global Environment Facility)	367	317,639	-	-	Completed	ODA	Donation	Mitigation & Adaptation
		APN (Asia-Pacific Network for Global Change Research)	35	30,293	-	-	Completed	ODA	Donation	Mitigation & Adaptation
		ADB (Asia Development Bank)	-	-	578	500,000	Completed	ODA	Grand Aid	Mitigation & Adaptation
		UNESCAP (United Nations Economic and Social Commission for Asia and the Pacific)	-	-	924	800,000	Completed	ODA	Grand Aid	Mitigation & Adaptation
	Energy	UNEP (United Nations Environment Program)	-	-	116	100,000	Completed	ODA	Grand Aid	Mitigation & Adaptation
	Forestry	FAO (Food and Agriculture Organization)	-	-	808	699,306	Completed	ODA	Donation	Mitigation & Adaptation
		ITTO (International Tropical Timber Organization)	-	-	298	257,912	Completed	ODA	Donation	Mitigation & Adaptation
		UNFF (United Nations Forum on Forests)	-	-	19	16,444	Completed	OOF (General budget)	Donation	Mitigation & Adaptation
		CIFOR (Center for International Forest Research)	167	150,000	-	-	Completed	ODA	Donation	-
	Other	FCF (Future Carbon Fund)	-	-	5,795	5,000,000	Completed	ODA	Stock or equity	Mitigation & Adaptation

Year	Sector	Multilateral institutions	Total				Status	Funding sources	Financial instruments	Support type
			General		Climate-related					
			million KRW	US Dollar	million KRW	US Dollar				
2011	All Sectors	CIF (Climate Investment Funds)	-	-	2,875	2,578,244	Completed	ODA	Donation	Mitigation & Adaptation
		UNFCCC (UN Framework Convention on Climate Change)	-	-	860	776,664 (EUR 573,333)	Completed	ODA	Donation	Mitigation & Adaptation
		GEF (Global Environment Facility)	2,295	2,072,609	-	-	Completed	ODA	Donation	Mitigation & Adaptation
		APN (Asia-Pacific Network for Global Change Research)	33	29,802	-	-	Completed	ODA	Donation	Mitigation & Adaptation
		UNIDO (UN Industrial Development Organization)	-	-	498	450,000	Completed	ODA	Grand Aid	Mitigation & Adaptation
		WB (World Bank)	-	-	332	300,000	Completed	ODA	Grand Aid	Mitigation & Adaptation
	Energy	UNEP (United Nations Environment Program)	-	-	558	504,000	Completed	ODA	Grand Aid	Mitigation & Adaptation
	Transport	IMO (International maritime Organization)	-	-	443	400,000	Completed	ODA	Grand Aid	Mitigation & Adaptation
	Forestry	FAO (Food and Agriculture Organization)	-	-	776	700,802	Completed	ODA	Donation	Mitigation & Adaptation
		ITTO (International Tropical Timber Organization)	-	-	276	249,254	Completed	ODA	Donation	Mitigation & Adaptation
		UNFF (United Nations Forum on Forests)	-	-	23	20,771	Completed	OOF (General budget)	Donation	Mitigation & Adaptation
		CIFOR (Center for International Forest Research)	282	250,000	-	-	Completed	ODA	Donation	-
	Waste management/ Waste	UNESCAP (United Nations Economic and Social Commission for Asia and the Pacific)	-	-	349	315,000	Completed	ODA	Grand Aid	Mitigation & Adaptation
	Other	FCF (Future Carbon Fund)	-	-	5,575	4,999,552	Completed	ODA	Stock or equity	Mitigation
		WMO (World Meteorological Organization)			1,329	1,200,000	Completed	ODA	Grand Aid	Mitigation & Adaptation
	Not designated	UNCCD (UN Convention to Combat Desertification)	1,758	1,587,643	-	-	Completed	ODA	Donation	-

Year	Sector	Multilateral institutions	Total				Status	Funding sources	Financial instruments	Support type
			General		Climate-related					
			million KRW	US Dollar	million KRW	US Dollar				
2012	All Sectors	GCF (Green Climate Funds)	-	-	2,350	2,177,943	Completed	others	Donation	Mitigation & Adaptation
		KGGTF (Korea Green Growth Trust Fund)	-	-	10,700	9,916,589	Completed	ODA	Donation	Mitigation & Adaptation
		UNFCCC (UN Framework Convention on Climate Change)	-	-	841	746,958 (EUR 560,667)	Completed	ODA	Donation	Mitigation & Adaptation
		GEF (Global Environment Facility)	1,745	1,549,871	-	-	Completed	ODA	Donation	Mitigation & Adaptation
		APN (Asia-Pacific Network for Global Change Research)	56	49,738	-	-	Completed	ODA	Donation	Mitigation & Adaptation
		UNIDO (UN Industrial Development Organization)	-	-	300	450,000	Completed	ODA	Grand Aid	Mitigation & Adaptation
		WB (World Bank)	-	-	150	200,000	Completed	ODA	Grand Aid	Mitigation & Adaptation
		UNEP (United Nations Environment Program)	-	-	214	190,000	Completed	ODA	Grand Aid	Mitigation & Adaptation
		OECD (Organization for Economic Cooperation and Development)	-	-	563	500,000	Completed	ODA	Grand Aid	Mitigation & Adaptation
	Energy	UNIDO (UN Industrial Development Organization)	-	-	300	266,445	Completed	ODA	Donation	Mitigation & Adaptation
		WB (World Bank)	-	-	150	133,222	Completed	ODA	Donation	Mitigation & Adaptation
		UNEP (United Nations Environment Program)	-	-	378	336,000	Completed	ODA	Grand Aid	Mitigation & Adaptation

Year	Sector	Multilateral institutions	Total				Status	Funding sources	Financial instruments	Support type
			General		Climate-related					
			million KRW	US Dollar	million KRW	US Dollar				
2012	Transport	IMO (International maritime Organization)	-	-	338	300,000	Completed	ODA	Grand Aid	Mitigation & Adaptation
	Forestry	FAO (Food and Agriculture Organization)	-	-	324	287,761	Completed	ODA	Donation	Mitigation & Adaptation
		ITTO (International Tropical Timber Organization)	-	-	371	329,504	Completed	ODA	Donation	Mitigation & Adaptation
		UNFF (UN Forestry Forum)	-	-	23	20,427	Completed	OOF (General budget)	Donation	Mitigation & Adaptation
		IUCN (International Union for Conservation of Nature)	-	-	11	9,770	Completed	ODA	Donation	Mitigation & Adaptation
		CIFOR (Center for International Forest Research)	279	250,000	-	-	Completed	ODA	Donation	-
	Waste management /Waste	UNESCAP (United Nations Economic and Social Commission for Asia and the Pacific)	-	-	355	315,000	Completed	ODA	Grand Aid	Mitigation & Adaptation
		UNIDO (UN Industrial Development Organization)	-	-	901	800,000	Completed	ODA	Grand Aid	Mitigation & Adaptation
	Other	FCF (Future Carbon Fund)	-	-	5,395	5,000,000	Completed	ODA	Stocks and shares	Mitigation
		WMO (World Meteorological Organization)	-	-	225	200,000	Completed	ODA	Grand Aid	Mitigation & Adaptation
	Not designated	UNCCD (UN Convention to Combat Desertification)	1,200	1,065,781	-	-	Completed	ODA	Donation	-
		UNEP (UN Environment Program)	173	153,650	-	-	Completed	ODA	Donation	-

Year	Sector	Multilateral institutions	Total				Status	Funding sources	Financial instruments	Support type
			General		Climate-related					
			million KRW	US Dollar	million KRW	US Dollar				
2013	All Sectors	GCF (Green Climate Funds)	-	-	1,130	1,069,063	Completed	Others	Donation	Mitigation & Adaptation
		KGGTF (Korea Green Growth Trust Fund)	-	-	10,700	10,122,990	Completed	ODA	Donation	Mitigation & Adaptation
		UNFCCC (UN Framework Convention on Climate Change)	-	-	786	743,614 (EUR 524,000)	Completed	ODA	Donation	Mitigation & Adaptation
		GEF (Global Environment Facility)	2,236	2,115,421	-	-	Completed	ODA	Donation	Mitigation & Adaptation
		APN (Asia-Pacific Network for Global Change Research)	52	49,196	-	-	Completed	ODA	Donation	Mitigation & Adaptation
		UNEP (UN Environment Program)	-	-	11	10,000	Completed	ODA	Grand Aid	Mitigation & Adaptation
		OECD (Organization for Economic Cooperation and Development)	-	-	326	298,000	Completed	ODA	Grand Aid	Mitigation & Adaptation
	Energy	UNIDO (UN Industrial Development Organization)	-	-	150	136,995	Completed	ODA	Donation	Mitigation
		ADB (Asia Development Bank)	-	-	150	136,995	Completed	ODA	Other (Cooperation business expense)	Mitigation
		WB (World Bank)	-	-	150	136,995	Completed	ODA	Donation	Mitigation

Year	Sector	Multilateral institutions	Total				Status	Funding sources	Financial instruments	Support type
			General		Climate-related					
			million KRW	US Dollar	million KRW	US Dollar				
2013	Forestry	FAO (Food and Agriculture Organization)	–	–	300	273,991	Completed	ODA	Donation	Mitigation & Adaptation
		ITTO (International Tropical Timber Organization)	–	–	395	360,755	Completed	ODA	Donation	Mitigation & Adaptation
		UNFF (UN Forestry Forum)	–	–	23	21,006	Completed	OOF (General budget)	Donation	Mitigation & Adaptation
		IUCN (International Union for Conservation of Nature)	–	–	11	10,046	Completed	ODA	Donation	Mitigation & Adaptation
		CIFOR (Center for International Forest Research)	223	200,000	–	–	Completed	ODA	Donation	–
	Waste management /Waste	UNIDO (UN Industrial Development Organization)	–	–	219	200,000	Completed	ODA	Grand Aid	Mitigation & Adaptation
	Other	FCF (Future Carbon Fund)	–	–	5,285	5,000,000	Completed	ODA	Stocks and shares	Mitigation
	Not designated	UNCCD (UN Convention to Combat Desertification)	1,826	1,667,693	–	–	Completed	ODA	Donation	–
		UNEP (UN Environment Program)	172	157,088	–	–	Completed	ODA	Donation	–

Table 4.2. Financial Assistance through Bilateral, Regional, and Other Channels (2010~2013)

Year	Sector	Country / Region	Total		Status	Funding sources	Financial instruments	Assistance type
			Climate-related					
			million KRW	US Dollar				
2010	Industry	Mongolia	18	15,477	Completed	ODA	Grants	ease
		Uzbekistan	2,434	2,106,426	Completed	ODA	Grants	Adaptation
	Agriculture and livestock	Mongolia	1,568	1,357,502	Completed	ODA	Grants	ease
		Indonesia	314	271,601	Completed	ODA	Grants	Cross-cutting
		China	190	164,393	Completed	ODA	Grants	Cross-cutting
		China	758	655,625	Completed	ODA	Grants	Cross-cutting
		Philippines	2,613	2,261,728	Completed	ODA	Grants	Adaptation
	Water resources	Cambodia	21,606	18,700,017	Completed	ODA	Concessional loan	Adaptation
		Indonesia	115,540	100,000,000	Completed	ODA	Concessional loan	Adaptation
		East Timor	33	28,309	Completed	ODA	Grants	Cross-cutting
	Other	Indonesia	1556	1,346,904	Completed	ODA	Grants	Adaptation
		China	22	18,791	Completed	ODA	Grants	ease

Year	Sector	Country / Region	Total		Status	Funding sources	Financial instruments	Assistance type
			Climate-related					
			million KRW	US Dollar				
2011	Industry	Mongolia	9,192	8,301,688	Completed	ODA	Grants	ease
	Agriculture and livestock	Mongolia	151	136,206	Completed	ODA	Grants	ease
		Indonesia	426	384,326	Completed	ODA	Grants	Cross-cutting
		China	293	264,312	Completed	ODA	Grants	Cross-cutting
		China	156	140,575	Completed	ODA	Grants	Cross-cutting
		Philippines	377	340,129	Completed	ODA	Grants	Adaptation
	Power industry	Vietnam	13,288	12,000,361	Completed	ODA	Concessional loan	Mitigation
		Nicaragua	30,119	27,200,397	Completed	ODA	Concessional loan	Mitigation
	Water resources	East Timor	2,256	2,037,792	Completed	ODA	Grants	Cross-cutting
	Other	Indonesia	1,232	1,112,440	Completed	ODA	Grants	Adaptation

Year	Sector	Country / Region	Total		Status	Funding sources	Financial instruments	Assistance type
			Climate-related					
			million KRW	US Dollar				
2012	All sectors	Vietnam	33,777	30,000,000	Completed	ODA	Concessional loan	Mitigation & Adaptation
	Industry	Morocco	821	729,339	Ongoing	ODA	Grants	ease
		Mongolia	9,374	8,325,613	Completed	ODA	Grants	ease
		Bangladesh	187	166,145	Completed	ODA	Grants	Adaptation
		Ecuador	2,506	2,225,302	Completed	ODA	Grants	Adaptation
		Cambodia	77	68,749	Completed	ODA	Grants	Adaptation
		Tajikistan	76	67,842	Completed	ODA	Grants	Adaptation
		Fiji	204	181,188	Completed	ODA	Grants	Adaptation
	Agriculture and livestock	Mongolia	10	8,618	Completed	ODA	Grants	ease
		China	204	181,346	Completed	ODA	Grants	Cross-cutting
		China	124	109,766	Completed	ODA	Grants	Cross-cutting
		Philippines	67	59,570	Completed	ODA	Grants	Adaptation
	Water resources	Vietnam	26,008	23,099,742	Scheduled	ODA	Concessional loan	Adaptation
		Jordan	32,539	28,900,435	Scheduled	ODA	Concessional loan	Adaptation
		Azerbaijan	48,977	43,500,311	Scheduled	ODA	Concessional loan	Adaptation
		East Timor	3,566	3,167,203	Completed	ODA	Grants	Cross-cutting
	Education	Indonesia	562	499,232	Completed	ODA	Grants	Cross-cutting
	Other	Indonesia	23	20,665	Completed	ODA	Grants	Adaptation

Year	Sector	Country / Region	Total		Status	Funding sources	Financial instruments	Assistance type
			Climate-related					
			million KRW	US Dollar				
2013	All sectors	Vietnam	21,892	20,000,000	Completed	ODA	Concessional loan	Mitigation & Adaptation
	Industry	Rwanda	650	593,806	Ongoing	ODA	Grants	Cross-cutting
		Morocco	1,028	939,124	Ongoing	ODA	Grants	ease
		Mongolia	5,614	5,127,222	Completed	ODA	Grants	ease
		Bangladesh	2,555	2,333,855	Completed	ODA	Grants	Adaptation
		Vietnam	900	822,190	Ongoing	ODA	Grants	Cross-cutting
		Vietnam	234	214,153	Ongoing	ODA	Grants	Cross-cutting
		Ecuador	4,290	3,918,186	Completed	ODA	Grants	Adaptation
		Indonesia	405	369,684	Ongoing	ODA	Grants	Cross-cutting
		Indonesia	1,171	1,069,391	Ongoing	ODA	Grants	Cross-cutting
		Indonesia	336	306,849	Ongoing	ODA	Grants	Cross-cutting
		Cambodia	10	8,828	Completed	ODA	Grants	Adaptation
		Tajikistan	99	90,401	Completed	ODA	Grants	Adaptation
		Fiji	35	31,974	Completed	ODA	Grants	Adaptation

Year	Sector	Country / Region	Total		Status	Funding sources	Financial instruments	Assistance type
			Climate-related					
			million KRW	US Dollar				
2013	Agriculture and livestock	Mongolia	118	107,674	Completed	ODA	Grants	ease
		Republic of the Union of Myanmar	400	365,418	Ongoing	ODA	Grants	Cross-cutting
		Solomon Is.	382	348,780	Ongoing	ODA	Grants	Adaptation
		Uzbekistan	392	358,295	Ongoing	ODA	Grants	Cross-cutting
		China	427	389,949	Completed	ODA	Grants	Cross-cutting
		China	103	94,034	Completed	ODA	Grants	Cross-cutting
		Philippines	1,840	1,680,420	Completed	ODA	Grants	Adaptation
		Philippines	965	881,301	Ongoing	ODA	Grants	Cross-cutting
	Water resource	Cambodia	51,118	46,700,164	Scheduled	ODA	Concessional loan	Adaptation
		Philippines	105,191	96,099,945	Scheduled	ODA	Concessional loan	Adaptation
		East Timor	3,468	3,167,203	Completed	ODA	Grants	Cross-cutting
	Education	Indonesia	220	200,768	Completed	ODA	Grants	Cross-cutting
	Others	Indonesia	26	23,752	Completed	ODA	Grants	Adaptation

4.2. Need of Technology and Assistance Status

Korea has carried out a wide range of energy technology cooperation projects with countries in Central and South America and Asia. In the power and industry sectors of developing countries in Central and South America in particular, it has provided energy diagnosis technologies for SMEs and has offered educational resources for device-specific diagnostic techniques, as well as site visits, etc., since 2012.

In the agriculture-livestock sector, Korea has offered wide-ranging assistance programs in Asian countries such as Thailand and the Philippines. Specifically, the Korean government has carried out projects for the development and dissemination of climate change response technologies. These projects have included the "Weather Information Production and Service for Climate Change Response in Agriculture" and "Rice Production Technology Development for the Increase of Staple Grains."

In the forestry sector, Korea has completed evaluations of forest carbon stocks in the West Rinjani Protected Forest Management Unit in Lombok, Indonesia and has provided a GIS-based forest information management program.

4.3. Need of Capacity Building and Assistance Status

Korea has offered the International Greenhouse Gas Professional Training Course as an annual education program since 2011. The training course is an intensive 4-week training program for selected officials, researchers, and graduate students from developing countries. The number of participant countries benefitting from this program has gradually increased each year: 44 people (from 21 countries) took part in the first program in 2011; 42 people (from 22 countries) took part in the second program in 2012; and 38 people (from 28 countries) took part in the third education program in 2013. Also, in order for developing countries to improve their adaptation capacity for climate change, Korea provided the support for policy establishment and technology transfer for the relevant sectors such as energy, water resources, forest, waste and disaster prevention in the KOICA projects.

Table 4.3. Technology Development and Transfer Assistance (2010~2013)

Sector affected	Recipient country / region	Targeted area	Measures and activities related to technology transfer	Funding source for technology transfer	Implementing agency	Status	Additional Information
Power and industry sector	Guatemala, Nicaragua, Mexico, El Salvador, Honduras, Costa Rica	Energy diagnosis technology transfer to the SMEs of developing countries in Central and South America	Diagnostic overview and education for device-specific diagnostic techniques, site visits and practice	IIC	Korea Energy Management Corp.	Implemented	Implemented in 2012
Agriculture and livestock Sector	Asia	Adaptation	Technology development and transfer	Public funds	Public agencies	Implemented	Asian Food & Agriculture Cooperation Initiative (AFACI) project Detailed project name: Climate change response agricultural weather information production and service - Period: Sept. 2012 to Aug. 2015 (3 years) - Targets: 11 countries (Thailand, Philippines, etc.) - Details: Climate change response agricultural weather information production and service
						Implemented	Asian Food & Agriculture Cooperation Initiative (AFACI) project Detailed project name: Technology development for rice production increases to improve self-sufficiency with staple grains - Period: Sept. 2012 to Aug. 2015 (3 years) - Targets: 10 countries (Thailand, Philippines, etc.) - Details: Cultivation technology development for improving rice production in response to climate change
Forestry Sector	Indonesia/ Lombok	Mitigation	Evaluation of forest carbon stocks in the West Rinjani Protected Forest Management Unit - Field survey and analysis - Research report publication	Others (R&D)	Public agencies	Completed	CIFOR working paper No.151. Amount of support : about 40 million KRW
			Provision of forest information management program - Program development and transfer			Implemented	GIS-based forest information management program - Provision of basic information (area, forest floor, etc.) - Ground coverage division, forest function division, etc. Amount of support : about 26 million KRW

Table 4.4. Details of Capacity Building Support (2010~2013)

Recipient Country / Region	Implementing Agency	Name of Project / Program		Targeted area	Additional Information
Developing countries, such as Azerbaijan, Bangladesh, Cambodia, Nepal, Pakistan, etc.	GIR	International Greenhouse Gas Professional Training Course	Greenhouse Gas Inventory Building Course	Developing countries Greenhouse gas Mitigation capacity building	Introduction of the inventory estimation Preparation for Inventory information management (QA/QC) plans Preparation for Common report format (CRF) and National inventory report (NIR) Understanding of calculation methods for sectors (energy, industrial processes, agriculture, LULUCF, Waste) Understanding of Uncertainty and indirect Greenhouse gas calculation
			Greenhouse Gas Reduction Analysis Model Course		Statistics (econometrics, STATA practice) Greenhouse gas emissions forecast model and practice for sectors (energy transformation, building, transport, industry, waste, etc.) Greenhouse gas reduction potential analysis and scenario deriving lessons and practice (LEAP)
China	KOICA	Environmental Management for Green Growth (China)		Various Sectors	Presentations for Green Growth
Cambodia	KOICA	Climate Change and Disaster Prevention		Adaptation	Policy of Climate Change and Disaster Prevention
Kyrgyzstan, Bangladesh, Philippines, Nicaragua, Morocco, Jamaica, Dominican Republic, Laos, Nigeria, Republic of the Union of Myanmar, Guatemala, Cameroon	KOICA	Expert Training for Energy and Climate Change		Adaptation	Improving effectiveness of energy policy
Republic of Cote d'Ivoire, Dominican Republic, Ecuador, Guatemala, Kyrgyzstan, Nicaragua, Nigeria, Philippines, Tanzania, Republic of Cote d'Ivoire, Vietnam, Zimbabwe, Cambodia, Indonesia, Republic of the Union of Myanmar, Nepal	KOICA	Waste Management & Waste-to-Energy for responding to climate change		Adaptation	Introducing Korea's Waste management and Waste-to-Energy policy

Recipient Country / Region	Implementing Agency	Name of Project / Program	Targeted area	Additional Information
Cambodia, Ecuador, Haiti, Mongolia, Republic of the Union of Myanmar, Peru, Philippines, Indonesia	KOICA	Water Resources Management for Responding to Climate Change	Adaptation	Sharing Korea's management experience in water resource sector
Papua New Guinea, Jamaica, Fiji, Republic of the Union of Myanmar, Philippines, Turkmenistan, Ecuador, Indonesia, Jordan	KOICA	Forestry Management for Climate Change Adaptation	Adaptation	Forest tree-planting, skill of climate change adaptation, forest disaster prevention
Cambodia, Ecuador, Haiti, Mongolia, Republic of the Union of Myanmar, Peru, Philippines, Indonesia	KOICA	Low Carbon Green Growth	Various Sectors	Awareness-raising of green growth and strengthening policy making abilities
Vietnam, Laos, Cambodia, Bangladesh, Sri Lanka, Vietnam, Cambodia, Laos	KOICA	Korea-Singapore Joint Training Program on Sustainable Development and Environmental Management	Various Sectors	Field trip of climate change, green growth, new renewable energy
El Salvador, Guatemala, Colombia, Panama, Costa Rica, Honduras, Belize, Commonwealth of Dominica, Nicaragua, Mexico,	KOICA	Korea-Mexico Joint Training Program on Climate Change and Green Growth	Various Sectors	Experience of Korea's environment policy and law of green growth

Recipient Country / Region	Implementing Agency	Name of Project / Program	Targeted area	Additional Information
Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka	KOICA	SAARC Special Training Program – Climate Change and Disaster Prevention	Various Sectors	Field trip, Inspection, lecture for building up disaster prevention systems
Fiji, Nauru, Samoa, Tuvalu, Solomon Is., Papua New Guinea, Tonga, Cook Islands	KOICA	PIF Special Training on Climate Change	Various Sectors	Strengthening Mitigatoin ability of GHG emission controls
Vietnam	KOICA	Training on Formulation and Development of Green Growth Strategy in Vietnam	Various Sectors	Korea's green growth policy and Green growth strategy
Republic of the Union of Myanmar, Cambodia, Laos, Malaysia, Republic of the Union of Myanmar, Philippines, Vietnam, Indonesia	KOICA	Response to Climate Change for ASEAN	Mitigation	New renewable energy policy and skill for climate change adaptation
Central Africa, Ethiopia, Kenya, Rwanda, Sudan, Tanzania, Uganda	KOICA	Improvement of Meteorological Disaster Responsiveness for African countries	Adaptation	Promoting understanding of Africa's climate and climate change issues, Preparation for climate and weather disaster

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APPENDIX : ANNEX

Table 5.1. Emission trends : summary

GREENHOUSE GAS EMISSIONS	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Change from 1990 to 2012
	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	(%)
CO_2 emissions including net CO_2 from LULUCF	218,419.35	242,098.64	267,865.67	301,073.17	325,132.48	350,703.83	379,298.11	396,418.93	322,472.23	351,631.51	383,361.68	400,948.59	420,098.56	427,132.83	435,327.10	438,147.36	443,924.84	466,131.11	479,532.56	486,081.42	539,088.87	572,166.57	574,811.46	163.17
CO_2 emissions excluding net CO_2 from LULUCF	252,824.79	275,734.10	299,582.30	334,880.67	357,248.93	386,138.93	418,697.73	444,388.82	378,150.38	410,401.09	442,311.36	457,695.39	476,113.15	484,358.00	490,500.91	494,782.91	501,203.89	524,216.83	537,070.95	540,791.98	593,962.56	623,438.17	625,748.37	147.50
CH_4 emissions including CH_4 from LULUCF	31,954.28	31,538.25	30,701.35	29,955.05	29,831.91	29,557.45	29,908.17	30,350.79	29,110.01	29,284.14	29,274.42	29,481.36	29,554.88	29,463.07	28,747.69	28,704.05	28,717.11	28,514.25	28,463.18	28,199.79	29,278.09	29,605.58	29,776.70	−6.81
CH_4 emissions excluding CH_4 from LULUCF	31,954.28	31,538.25	30,701.35	29,955.05	29,831.91	29,557.45	29,908.17	30,350.79	29,110.01	29,284.14	29,274.42	29,481.36	29,554.88	29,463.07	28,747.69	28,704.05	28,717.11	28,514.25	28,463.18	28,199.79	29,278.09	29,605.58	29,776.70	−6.81
N_2O emissions including N_2O from LULUCF	9,562.05	9,752.76	12,120.30	12,503.04	13,364.74	14,366.88	15,227.50	16,271.39	16,857.71	17,727.99	18,332.43	18,336.05	17,922.40	21,141.30	23,694.66	22,079.38	21,186.07	12,408.95	12,785.26	12,735.46	13,293.66	13,880.53	14,237.14	48.89
N_2O emissions excluding N_2O from LULUCF	9,562.05	9,752.76	12,120.30	12,503.04	13,364.74	14,366.88	15,227.50	16,271.39	16,857.71	17,727.99	18,332.43	18,336.05	17,922.40	21,141.30	23,694.66	22,079.38	21,186.07	12,408.95	12,785.26	12,735.46	13,293.66	13,880.53	14,237.14	48.89
HFC_s	982.80	798.88	1,877.21	2,117.21	3,837.90	5,084.87	5,779.02	7,160.07	4,911.10	8,061.49	8,443.31	5,851.64	8,652.61	6,442.92	6,590.97	6,651.18	6,097.96	7,362.99	6,881.07	5,846.15	8,087.59	7,906.95	8,694.42	784.66
PFC_s	NO	NO	NO	NO	NO	NO	NO	1,682.59	1,649.15	1,878.66	2,238.78	1,984.30	1,967.37	2,266.90	2,774.07	2,796.76	2,925.12	2,977.49	2,792.21	2,046.08	2,260.82	2,070.22	2,263.71	0.00
SF_6	175.90	335.11	346.72	387.08	542.37	1,449.32	1,188.95	1,531.72	1,001.10	2,974.76	2,477.86	2,311.84	2,361.87	3,362.34	3,898.78	4,917.55	5,174.31	7,279.53	7,693.57	8,205.99	10,258.28	8,828.86	7,621.22	4,232.77
Total (including LULUCF)	261,094.38	284,523.63	312,911.25	346,035.55	372,709.40	401,162.36	431,401.76	453,415.49	376,001.30	411,558.56	444,128.47	458,913.78	480,557.69	489,809.37	501,033.27	503,296.27	508,025.42	524,674.31	538,147.85	543,114.90	602,267.32	634,458.72	637,404.66	144.13
Total (excluding LULUCF)	295,499.82	318,159.09	344,627.88	379,843.05	404,825.86	436,597.46	470,801.37	501,385.38	431,679.44	470,328.13	503,078.16	515,660.58	536,572.29	547,034.53	556,207.08	559,931.83	565,304.47	582,760.03	595,686.24	597,825.46	657,141.01	685,730.31	688,341.56	132.94

NO : Not Occurring

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Change from 1990 to 2012
	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	(%)
1. Energy	241,450.47	259,437.95	279,363.86	309,539.06	328,792.80	354,684.12	386,721.66	411,251.82	351,373.59	382,433.44	411,937.13	426,109.15	445,039.01	452,714.58	460,754.59	468,848.11	475,256.02	494,290.12	508,599.24	514,907.13	568,636.15	597,603.22	600,255.01	148.60
2. Industrial Processes	20,378.02	24,122.73	29,657.40	33,823.78	38,370.13	42,629.31	43,745.03	48,913.88	40,272.68	47,557.97	49,603.49	48,057.53	51,706.46	54,872.68	57,245.52	53,889.79	52,631.93	52,307.87	51,072.43	46,606.99	52,418.11	51,682.95	51,282.85	151.66
3. Solvent and Other Product Use	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
4. Agriculture	23,757.07	23,592.20	23,599.39	23,741.08	24,212.57	24,500.49	24,749.06	24,935.60	25,010.16	24,510.21	23,742.73	22,825.99	22,222.47	21,746.32	21,603.37	21,512.13	21,385.08	21,470.17	21,527.89	21,846.58	21,962.87	21,863.91	21,992.85	-7.43
5. Land Use, Land-Use Change and Forestry[b]	-34,405.44	-33,635.46	-31,716.63	-33,807.50	-32,116.45	-35,435.10	-39,399.62	-47,969.89	-55,678.14	-58,769.58	-58,949.68	-56,746.80	-56,014.59	-57,225.17	-55,173.81	-56,635.56	-57,279.05	-58,085.72	-57,538.39	-54,710.56	-54,873.69	-51,271.60	-50,936.90	48.05
6. Waste	9,914.26	11,006.21	12,007.23	12,739.13	13,450.36	14,783.54	15,585.63	16,284.09	15,023.01	15,826.50	17,794.81	18,667.91	17,604.35	17,700.95	16,603.61	15,681.80	16,031.44	14,691.87	14,486.68	14,464.76	14,123.89	14,580.23	14,810.85	49.39
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)	261,094.38	284,523.63	312,911.25	346,035.55	372,709.40	401,162.36	431,401.76	453,415.49	376,001.30	411,558.56	444,128.47	458,913.78	480,557.69	489,809.37	501,033.27	503,296.27	508,025.42	524,674.31	538,147.85	543,114.90	602,267.32	634,458.72	637,404.66	144.13

NA : Not Applicable
NO : Not Occurring

Table 5.2. Emission trends(CO_2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq
1. Energy	232,486.14	251,413.82	272,438.80	303,380.73	323,157.30	349,344.54	381,142.08	405,345.83	345,897.20	376,407.89	405,474.13	419,366.52	437,903.18	445,346.25	452,706.68	460,525.69	466,603.59	485,083.23	498,433.94	505,488.91	557,464.89	585,432.29	587,222.03
A. Fuel Combustion (Sectoral Approach)	232,486.14	251,413.82	272,438.80	303,380.73	323,157.30	349,344.54	381,142.08	405,345.83	345,897.20	376,407.89	405,474.13	419,366.52	437,903.18	445,346.25	452,706.68	460,525.69	466,603.59	485,083.23	498,433.94	505,488.91	557,464.89	585,432.29	587,222.03
1. Energy Industries	47,511.27	53,947.78	61,405.64	68,456.97	82,273.90	91,304.44	107,243.74	120,791.76	104,776.79	114,483.55	134,532.46	145,633.87	154,059.27	158,120.65	171,571.15	176,740.83	185,781.49	197,244.60	210,490.30	229,471.23	254,815.11	262,574.97	265,905.94
2. Manufacturing Industries and Construction	76,102.99	88,221.13	97,330.29	107,438.12	112,417.40	116,092.76	123,704.07	127,445.98	118,551.79	124,166.29	128,805.11	129,192.24	134,732.01	136,951.62	134,345.18	133,708.04	135,090.97	141,471.89	146,029.15	135,673.24	159,739.89	180,983.88	178,335.68
3. Transport	35,240.16	38,319.68	43,645.12	55,171.56	57,153.19	64,262.38	68,301.79	73,659.27	57,099.87	62,093.11	69,381.54	72,505.32	77,448.98	80,235.11	80,388.67	81,196.10	81,977.10	84,247.13	82,079.32	82,917.13	84,619.88	84,248.28	85,658.86
4. Other Sectors	73,631.72	70,925.24	70,057.74	72,314.09	71,312.80	77,684.96	81,892.48	83,448.82	65,468.74	75,664.94	72,755.03	72,035.08	71,662.92	70,038.87	66,401.69	68,880.72	63,754.02	62,119.61	59,835.16	57,427.31	58,290.02	57,625.16	57,321.55
5. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
B. Fugitive Emissions from Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Industrial Processes	18,945.28	22,448.14	24,820.99	28,670.33	31,100.71	32,715.50	32,941.22	33,928.82	27,470.69	28,414.32	29,392.10	30,462.20	31,482.67	32,233.05	31,028.16	28,440.09	28,145.99	33,396.91	32,963.33	29,769.66	31,080.42	32,055.76	31,977.17
A. Mineral Products	18,095.00	21,622.47	23,923.79	27,855.33	29,928.34	31,450.17	31,704.57	32,831.99	26,425.00	27,386.27	28,540.89	29,584.65	30,989.15	31,834.86	30,554.82	27,957.95	27,848.52	33,059.74	32,584.38	29,463.94	30,756.02	31,823.67	31,793.99
B. Chemical Industry	754.84	747.77	812.35	707.48	1,051.46	1,127.53	1,090.93	930.20	908.56	886.49	703.51	733.93	340.14	241.03	303.97	287.96	154.42	156.98	159.96	150.46	146.63	53.61	1.81
C. Metal Production	95.43	77.90	84.84	107.53	120.91	137.80	145.72	166.63	137.13	141.56	147.70	143.61	153.39	157.16	169.37	194.18	143.06	180.18	218.99	155.26	177.77	178.47	181.37
D. Other Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Production of Halocarbons and SF_6																							
F. Consumption of Halocarbons and SF_6																							
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
4. Agriculture																							
A. Enteric Fermentation																							
B. Manure Management																							
C. Rice Cultivation																							
D. Agricultural Soils																							
E. Prescribed Burning of Savannas																							

NA : Not Applicable
NO : Not Occurring
NE : Not Estimated

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq
F. Field Burning of Agricultural Residues																							
G. Other																							
5. Land Use, Land-Use Change and Forestry	-34,405.44	-33,635.46	-31,716.63	-33,807.50	-32,116.45	-35,435.10	-39,399.62	-47,969.89	-55,678.14	-58,769.58	-58,949.68	-56,746.80	-56,014.59	-57,225.17	-55,173.81	-56,635.56	-57,279.05	-58,085.72	-57,538.39	-54,710.56	-54,873.69	-51,271.60	-50,936.90
A. Forest Land	-34,603.37	-34,035.16	-32,439.29	-34,810.25	-33,484.00	-37,523.56	-42,536.86	-51,347.36	-59,161.29	-62,229.80	-61,800.16	-59,693.90	-59,110.52	-60,410.61	-58,402.29	-60,000.81	-61,021.89	-62,222.04	-61,988.73	-59,414.38	-59,674.94	-56,218.22	-55,306.76
B. Cropland	546.98	781.15	1,083.59	1,348.12	1,712.61	2,405.46	2,907.84	3,160.24	3,270.10	3,248.77	3,234.05	3,313.48	3,431.31	3,516.58	3,540.53	3,656.23	3,924.73	4,246.91	4,509.03	4,739.62	4,828.28	4,939.25	4,378.66
C. Grassland	-535.71	-567.90	-548.87	-543.35	-542.16	-555.91	-568.28	-580.01	-581.84	-581.23	-587.40	-568.68	-532.49	-519.41	-484.80	-415.29	-282.50	-217.12	-184.08	-169.20	-155.57	-117.70	-127.35
D. Wetlands	186.67	186.44	187.95	197.98	197.10	238.91	229.40	217.22	213.04	211.45	203.83	202.30	197.11	188.27	172.74	124.32	100.61	106.53	125.39	133.40	128.53	125.06	118.55
E. Settlements	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
F. Other Land	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	1,393.37	1,872.14	2,322.51	2,829.60	2,990.92	4,078.89	4,614.43	5,114.17	4,782.49	5,578.87	7,445.13	7,866.68	6,727.30	6,778.70	6,766.07	5,817.13	6,454.32	5,736.69	5,673.68	5,533.41	5,417.26	5,950.12	6,549.18
A. Solid Waste Disposal on Land	NA, NO	NA, NO	NA, NO	NA,NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
B. Waste-water Handling																							
C. Waste Incineration	1,393.37	1,872.14	2,322.51	2,829.60	2,990.92	4,078.89	4,614.43	5,114.17	4,782.49	5,578.87	7,445.13	7,866.68	6,727.30	6,778.70	6,766.07	5,817.13	6,454.32	5,736.69	5,673.68	5,533.41	5,417.26	5,950.12	6,549.18
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other (as specified in the summary table in CRF)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total CO_2 emissions including net CO_2 from LULUCF	218,419.35	242,098.64	267,865.67	301,073.17	325,132.48	350,703.83	379,298.11	396,418.93	322,472.23	351,631.51	383,361.68	400,948.59	420,098.56	427,132.83	435,327.10	438,147.36	443,924.84	466,131.11	479,532.56	486,081.42	539,088.87	572,166.57	574,811.46
Total CO_2 emissions excluding net CO_2 from LULUCF	252,824.79	275,734.10	299,582.30	334,880.67	357,248.93	386,138.93	418,697.73	444,388.82	378,150.38	410,401.09	442,311.36	457,695.39	476,113.15	484,358.00	490,500.91	494,782.91	501,203.89	524,216.83	537,070.95	540,791.98	593,962.56	623,438.17	625,748.37
Memo Items:																							
International Bunkers	11,549.66	16,680.79	20,706.45	21,942.13	25,291.90	29,140.12	34,727.82	38,113.20	37,704.09	40,789.00	38,665.72	37,786.96	37,867.17	40,494.92	42,272.37	42,722.32	40,805.27	41,382.80	38,983.27	35,772.06	38,237.47	37,962.05	37,098.81
Aviation	3,873.59	4,220.26	5,049.68	5,582.38	6,269.03	7,088.31	7,746.31	8,435.32	6,990.95	7,216.82	7,617.57	7,982.65	9,016.58	9,476.28	10,099.02	10,510.13	8,522.48	12,006.38	10,953.97	10,433.67	11,615.78	11,715.08	11,781.54
Marine	7,676.07	12,460.53	15,656.77	16,359.75	19,022.87	22,051.80	26,981.51	29,677.88	30,713.13	33,572.18	31,048.15	29,804.31	28,850.58	31,018.63	32,173.35	32,212.20	32,282.78	29,376.42	28,029.30	25,338.40	26,621.68	26,246.97	25,317.27
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
CO_2 Emissions from Biomass	3,656.50	2,781.63	3,257.90	3,337.25	4,076.49	4,718.91	5,177.39	5,956.06	6,796.43	8,090.77	9,569.82	11,093.64	13,262.11	14,689.83	18,006.74	17,818.76	19,415.83	21,360.94	22,623.56	23,148.83	25,168.85	27,352.86	33,028.53

NA : Not Applicable
NO : Not Occurring
NE : Not Estimated

Table 5.3. Emission trends(CH_4)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq
1. Energy	389.77	343.59	288.05	247.70	221.09	203.97	212.16	224.66	209.29	231.89	248.72	259.64	274.21	283.53	313.60	326.19	340.88	363.91	370.92	352.18	419.44	448.54	478.72
A. Fuel Combustion (Sectoral Approach)	134.21	112.79	89.92	75.21	61.65	56.25	52.76	51.31	46.29	49.56	52.95	55.18	60.60	63.06	62.88	67.44	69.01	71.48	73.13	72.25	77.54	81.79	82.47
1. Energy Industries	0.64	0.72	0.98	1.27	1.67	1.87	2.12	2.45	2.21	2.46	2.58	2.80	3.15	3.22	4.01	4.15	4.63	5.10	5.48	5.17	6.34	6.70	6.70
2. Manufacturing Industries and Construction	5.89	6.91	8.44	9.59	10.06	10.64	11.62	12.46	12.54	13.27	14.47	15.24	16.00	16.63	17.60	17.54	18.08	19.45	20.34	19.42	22.65	25.47	26.42
3. Transport	6.84	7.52	8.66	10.24	11.42	12.76	13.93	14.82	13.06	14.80	17.09	18.39	19.55	20.07	20.41	21.00	21.71	22.81	23.03	23.94	24.47	24.02	23.87
4. Other Sectors	120.84	97.65	71.84	54.11	38.51	30.98	25.08	21.58	18.48	19.04	18.81	18.76	21.90	23.14	20.86	24.74	24.59	24.11	24.28	23.73	24.09	25.59	25.48
5. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
B. Fugitive Emissions from Fuels	255.56	230.79	198.13	172.49	159.44	147.72	159.40	173.34	163.00	182.33	195.78	204.46	213.61	220.47	250.72	258.76	271.87	292.44	297.79	279.93	341.90	366.75	396.25
1. Solid Fuels	230.13	201.27	160.00	126.22	99.42	76.46	66.18	60.34	58.29	56.10	55.47	51.02	44.35	44.08	42.65	37.85	37.75	38.58	37.07	33.67	27.86	27.86	27.99
2. Oil and Natural Gas	25.43	29.52	38.14	46.27	60.02	71.26	93.22	113.01	104.71	126.23	140.30	153.44	169.26	176.39	208.07	220.90	234.12	253.86	260.72	246.26	314.04	338.89	368.26
2. Industrial Processes	5.31	7.40	10.51	11.72	12.53	12.87	14.59	17.82	18.60	19.77	20.66	19.80	21.54	21.42	21.98	22.42	23.34	24.48	23.73	23.95	24.89	24.34	25.83
A. Mineral Products	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Chemical Industry	5.31	7.40	10.51	11.72	12.53	12.87	14.59	17.82	18.60	19.77	20.66	19.80	21.54	21.42	21.98	22.42	23.34	24.48	23.73	23.95	24.89	24.34	25.83
C. Metal Production	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO
D. Other Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Production of Halocarbons and SF_6																							
F. Consumption of Halocarbons and SF_6																							
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
4. Agriculture	768.43	761.07	749.09	742.09	736.37	730.60	725.79	723.02	722.76	709.18	689.52	668.28	653.21	637.98	624.78	613.73	608.07	605.84	604.88	606.46	606.51	599.23	595.06
A. Enteric Fermentation	142.05	144.08	150.49	162.92	176.20	188.05	198.85	206.51	209.09	197.67	180.47	162.22	152.59	148.14	149.37	152.59	158.43	164.90	172.85	181.25	191.40	197.96	204.31
B. Manure Management	38.71	39.55	40.28	42.42	44.45	46.40	48.04	49.39	50.83	51.70	52.99	54.08	55.69	56.63	56.66	56.44	56.48	57.27	57.37	57.91	58.87	57.74	58.00
C. Rice Cultivation	586.13	576.08	557.01	535.45	514.42	494.70	477.25	465.30	461.09	457.97	454.15	449.90	442.93	431.30	416.87	402.79	391.23	381.75	372.78	365.43	354.52	341.99	331.29
D. Agricultural Soils																							
E. Prescribed Burning of Savannas																							

NO : Not Occurring
NE : Not Estimated
IE : Included Elsewhere
NA : Not Applicable

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq
F. Field Burning of Agricultural Residues	1.44	1.28	1.24	1.24	1.24	1.40	1.59	1.76	1.70	1.80	1.87	2.04	1.96	1.87	1.85	1.88	1.90	1.88	1.85	1.85	1.71	1.55	1.46
G. Other																							
5. Land Use, Land-Use Change and Forestry(2)	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
A. Forest Land	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
B. Cropland	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
C. Grassland	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
D. Wetlands	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
E. Settlements	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
F. Other Land	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
G. Other	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
6. Waste	358.21	389.85	414.39	424.99	450.63	460.11	471.66	479.83	435.58	433.68	435.15	456.19	458.46	460.12	408.61	404.55	395.22	363.63	355.90	360.28	343.37	337.68	318.33
A. Solid Waste Disposal on Land	328.30	358.94	381.87	399.08	415.54	425.55	438.05	452.02	408.51	406.34	406.70	426.86	425.77	429.42	378.81	372.72	361.00	330.43	324.92	328.46	319.31	313.48	296.53
B. Waste-water Handling	29.91	30.91	32.52	25.90	34.73	34.51	33.47	27.41	26.71	26.019	25.79	26.69	28.67	26.57	25.50	25.26	26.48	24.67	22.34	22.30	21.33	21.62	20.50
C. Waste Incineration	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
D. Other	NO	NO	NO	NO	0.36	0.04	0.13	0.40	0.36	1.32	2.66	2.64	4.02	4.12	4.30	6.57	7.74	8.53	8.63	9.52	2.74	2.57	1.29
7. Other (as specified in the summary table in CRF)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total CH_4 emissions including CH_4 from LULUCF	1,521.63	1,501.82	1,461.97	1,426.43	1,420.57	1,407.50	1,424.20	1,445.28	1,386.19	1,394.48	1,394.02	1,403.87	1,407.38	1,403.00	1,368.94	1,366.86	1,367.48	1,357.82	1,355.39	1,342.85	1,394.19	1,409.79	1,417.94
Total CH_4 emissions excluding CH_4 from LULUCF	1,521.63	1,501.82	1,461.97	1,426.43	1,420.57	1,407.50	1,424.20	1,445.28	1,386.19	1,394.48	1,394.02	1,403.87	1,407.38	1,403.00	1,368.94	1,366.86	1,367.48	1,357.82	1,355.39	1,342.85	1,394.19	1,409.79	1,417.94
Memo Items:																							
International Bunkers	0.53	0.85	1.06	1.11	1.29	1.50	1.83	2.01	2.07	2.26	2.09	2.01	1.96	2.10	2.18	2.19	2.18	2.04	1.94	1.76	1.85	1.83	1.78
Aviation	0.03	0.03	0.04	0.04	0.04	0.05	0.05	0.06	0.05	0.05	0.05	0.06	0.06	0.07	0.07	0.07	0.06	0.08	0.08	0.07	0.08	0.08	0.08
Marine	0.51	0.82	1.03	1.07	1.25	1.45	1.78	1.95	2.02	2.21	2.04	1.96	1.89	2.04	2.11	2.11	2.12	1.95	1.86	1.68	1.77	1.74	1.70
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
CO_2 Emissions from Biomass																							

NE : Not Estimated
NO : Not Occurring
NA : Not Applicable

Table 5.4. Emission trends(N_2O)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq
1. Energy	2.51	2.61	2.83	3.09	3.20	3.41	3.63	3.83	3.49	3.73	4.00	4.16	4.44	4.56	4.72	4.75	4.82	5.05	7.66	6.52	7.62	8.88	9.61
A. Fuel Combustion (Sectoral Approach)	2.51	2.61	2.83	3.09	3.20	3.41	3.63	3.83	3.49	3.73	4.00	4.16	4.44	4.56	4.72	4.75	4.82	5.05	7.66	6.52	7.62	8.88	9.61
1. Energy Industries	0.31	0.34	0.38	0.41	0.46	0.50	0.55	0.60	0.57	0.61	0.72	0.80	0.89	0.90	0.99	1.01	1.07	1.10	3.67	2.65	3.34	4.23	4.83
2. Manufacturing Industries and Construction	0.98	1.14	1.39	1.57	1.66	1.73	1.87	1.99	1.96	2.07	2.22	2.30	2.41	2.50	2.62	2.61	2.67	2.87	2.95	2.82	3.21	3.56	3.69
3. Transport	0.30	0.33	0.37	0.47	0.49	0.55	0.58	0.63	0.49	0.52	0.57	0.59	0.63	0.65	0.64	0.64	0.64	0.65	0.63	0.64	0.65	0.65	0.66
4. Other Sectors	0.92	0.81	0.68	0.64	0.60	0.62	0.62	0.61	0.47	0.53	0.48	0.48	0.51	0.52	0.47	0.49	0.44	0.43	0.41	0.41	0.42	0.43	0.43
5. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
B. Fugitive Emissions from Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Industrial Processes	0.52	1.24	7.72	7.75	8.47	10.03	11.39	13.67	15.64	18.75	21.35	22.68	21.90	32.64	40.30	34.24	31.61	2.51	0.79	0.76	0.67	1.00	0.59
A. Mineral Products	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Chemical Industry	0.52	1.24	7.72	7.75	8.47	10.03	11.39	13.67	15.64	18.75	21.35	22.68	21.90	32.64	40.30	34.24	31.61	2.51	0.79	0.76	0.67	1.00	0.59
C. Metal Production																							
D. Other Production																							
E. Production of Halocarbons and SF_6																							
F. Consumption of Halocarbons and SF_6																							
G. Other																							
3. Solvent and Other Product Use																							
4. Agriculture	24.59	24.55	25.39	26.32	28.23	29.55	30.67	31.46	31.72	31.03	29.88	28.36	27.44	26.93	27.37	27.82	27.79	28.22	28.47	29.39	29.76	29.94	30.63
A. Enteric Fermentation																							
B. Manure Management	7.44	7.67	8.19	8.98	9.72	10.39	11.05	11.55	11.74	11.34	10.73	10.10	9.84	9.76	9.90	10.18	10.58	11.02	11.35	11.78	12.34	12.67	13.03
C. Rice Cultivation																							
D. Agricultural Soils	17.12	16.85	17.17	17.31	18.48	19.12	19.58	19.87	19.94	19.64	19.11	18.21	17.56	17.13	17.42	17.60	17.17	17.16	17.08	17.57	17.38	17.23	17.57
E. Prescribed Burning of Savannas																							

NO : Not Occurring
NE : Not Estimated

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq
F. Field Burning of Agricultural Residues	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.04	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04
G. Other																							
5. Land Use, Land-Use Change and Forestry(2)	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
A. Forest Land	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
B. Cropland	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
C. Grassland	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
D. Wetlands	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
E. Settlements	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
F. Other Land	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
G. Other	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
6. Waste	3.22	3.06	3.17	3.18	3.21	3.36	3.44	3.53	3.53	3.68	3.91	3.94	4.03	4.06	4.05	4.42	4.12	4.25	4.32	4.40	4.83	4.96	5.09
A. Solid Waste Disposal on Land																							
B. Waste-water Handling	3.10	2.90	2.98	2.94	2.95	3.03	3.06	3.09	3.11	3.10	3.09	3.08	3.06	3.04	3.02	3.31	2.97	2.94	3.00	3.05	3.38	3.38	3.35
C. Waste Incineration	0.12	0.16	0.19	0.23	0.24	0.33	0.37	0.41	0.39	0.48	0.62	0.66	0.67	0.71	0.71	0.61	0.57	0.67	0.68	0.64	0.80	0.81	0.95
D. Other	NO	NO	NO	NO	0.03	0.00	0.01	0.03	0.03	0.10	0.20	0.20	0.30	0.31	0.32	0.49	0.58	0.64	0.65	0.71	0.64	0.78	0.80
7. Other (as specified in the summary table in CRF)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total N_2O emissions including N_2O from LULUCF	30.85	31.46	39.10	40.33	43.11	46.34	49.12	52.49	54.38	57.19	59.14	59.15	57.81	68.20	76.43	71.22	68.34	40.03	41.24	41.08	42.88	44.78	45.93
Total N_2O emissions excluding N_2O from LULUCF	30.85	31.46	39.10	40.33	43.11	46.34	49.12	52.49	54.38	57.19	59.14	59.15	57.81	68.20	76.43	71.22	68.34	40.03	41.24	41.08	42.88	44.78	45.93
Memo Items:																							
International Bunkers	2.51	3.21	3.93	4.23	4.83	5.52	6.37	6.97	6.49	6.92	0.46	0.46	0.48	0.51	0.54	0.55	0.49	0.57	0.53	0.50	0.54	0.54	0.53
Aviation	1.62	1.76	2.11	2.33	2.61	2.96	3.23	3.52	2.92	3.01	0.22	0.23	0.25	0.27	0.29	0.30	0.24	0.34	0.31	0.29	0.33	0.33	0.33
Marine	0.89	1.45	1.82	1.90	2.21	2.57	3.14	3.45	3.58	3.91	0.24	0.23	0.23	0.24	0.25	0.25	0.25	0.23	0.22	0.20	0.21	0.21	0.20
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
CO_2 Emissions from Biomass																							

NE : Not Estimated
NO : Not Occurring
NA : Not Applicable

Table 5.5. Emission trends(HFCs, PFCs and SF_6)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq
Emissions of HFCs – (kt CO_2eq)	982.80	798.88	1,877.21	2,117.21	3,837.90	5,084.87	5,779.02	7,160.07	4,911.10	8,061.49	8,443.31	5,851.64	8,652.61	6,442.92	6,590.97	6,651.18	6,097.96	7,362.99	6,881.07	5,846.15	8,087.59	7,906.95	8,694.42
HFC-23	0.08	0.07	0.16	0.18	0.19	0.22	0.24	0.29	0.17	0.32	0.29	0.05	0.18	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.03
HFC-32	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.01
HFC-41	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-43-10mee	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-125	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-134	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-134a	NO	NO	NO	NO	1.21	1.90	2.25	2.92	2.21	3.32	3.90	4.00	5.01	4.83	4.94	4.97	4.51	5.45	5.11	4.33	6.03	5.88	6.44
HFC-152a	NO	NO	0.04	0.08	0.00	0.00	0.00	0.01	0.00	0.03	0.22	0.11	0.36	0.33	0.12	0.16	0.22	0.24	0.07	0.05	0.07	0.07	0.06
HFC-143	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-143a	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-227ea	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-236fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-245ca	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of listed HFCs – (kt CO_2eq)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Emissions of PFCs – (kt CO_2eq)	NO	NO	NO	NO	NO	NO	NO	94.57	93.96	94.24	2,238.78	1,984.30	1,967.37	2,266.90	2,774.07	2,796.76	2,925.12	2,977.49	2,792.21	2,046.08	2,260.82	2,070.22	2,263.71
CF_4	NO	NO	NO	NO	NO	NO	NO	0.09	0.09	0.09	0.09	0.07	0.08	0.10	0.13	0.14	0.19	0.22	0.21	0.17	0.19	0.17	0.22
C_2F_6	NO	NO	NO	NO	NO	NO	NO	0.12	0.11	0.14	0.17	0.14	0.11	0.11	0.12	0.11	0.11	0.12	0.11	0.07	0.08	0.07	0.06
C 3F8	NO	NO	NO	NO	NO	NO	NO	0.00	NO	0.00	0.01	0.03	0.06	0.09	0.12	0.11	0.08	0.05	0.04	0.03	0.03	0.03	0.03
C_4F_{10}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
c-C_4F_8	NO	NO	NO	NO	NO	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C_5F_{12}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_6F_{14}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of listed PFCs – (kt CO_2eq)	NO	NO	NO	NO	NO	NO	NO	0.09	0.09	0.09	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Emissions of SF_6 – (kt CO_2eq)	175.90	335.11	346.72	387.08	542.37	1,449.32	1,188.95	1,531.72	1,001.10	2,974.76	2,477.86	2,311.84	2,361.87	3,362.34	3,898.78	4,917.55	5,174.31	7,279.53	7,693.57	8,205.99	10,258.28	8,828.86	7,621.22
SF_6	0.01	0.01	0.01	0.02	0.02	0.06	0.05	0.06	0.04	0.12	0.10	0.10	0.10	0.14	0.16	0.21	0.22	0.30	0.32	0.34	0.43	0.37	0.32

NO : Not Occurring