

2006 Greenhouse Gas and Air Pollutants Emissions in Korea

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**National Institute of
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Summary

This report presents two kinds of emission data. One is Greenhouse Gas(GHG) emission data, the other is air pollutants emissions data. GHG emission data are estimated by the National Institute of Environmental Research(NIER) in Korea based on statistical calculation system called GHG-CAPSS(Clean Air Policy Support System). GHG emission data presents the latest estimates of regional emissions for major GHG, such as Carbon Dioxide(CO₂), Methane(CH₄) and Nitrous Oxides(N₂O), except for HFCs, PFCs and SF₆. Estimates are presented for the years from 2001 to 2006. Categories of GHG emissions by sources are combustion in energy production, non-industrial combustion, industrial processes, fugitive emissions, road transportation, non-road transportation, agriculture, and waste based on IPCC Guidelines.

Then, air pollutants emission data presents the Korea Ministry of Environment's latest estimates of national and regional emissions for criteria of air pollutants, such as Sulfur Oxides(SO_x), Nitrogen Oxides(NO_x), Fine Particulate matters(PM₁₀), Carbon Monoxide(CO), and Volatile Organic Compounds(VOCs). Estimates are presented for the years from 1999 to 2006. National Emissions are estimated annually by the NIER based on CAPSS. The yearly national air pollutants emission data has been estimated by CAPSS according to emission inventories(point, area, mobile, fugitive and natural) since 1999.

I . Greenhouse Gas Emissions

1. 2006 Emissions

1-1

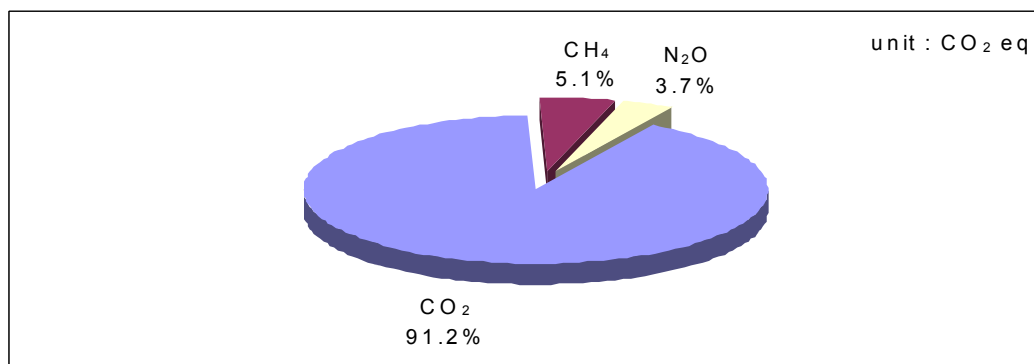
Emissions Summary by GHG

The 2006 emission data(Bottom-Up Approach data) in this report are developed using the GHG-CAPSS of NIER. Table 1 shows 2006 greenhouse gas emissions data in Korea. CO₂ emissions occupied the largest share with 470,411 thousand tons, followed by CH₄ emissions with 1,249 thousand tons and N₂O emissions with 62 thousand tons. Figure 1 shows the contribution rate of greenhouse gas in 2006.

<Table 1> Greenhouse gas emissions in 2006

Unit	CO ₂	CH ₄	N ₂ O	Total
ton/yr	470,411,445	1,249,137	62,204	471,722,787
CO ₂ eq. ton/yr	470,411,445	26,231,877	19,283,240	515,926,562

※ HFCs, PFCs, and SF₆ emission data will be estimated next year



<Figure 1> Contribution rates of GHG emissions in 2006

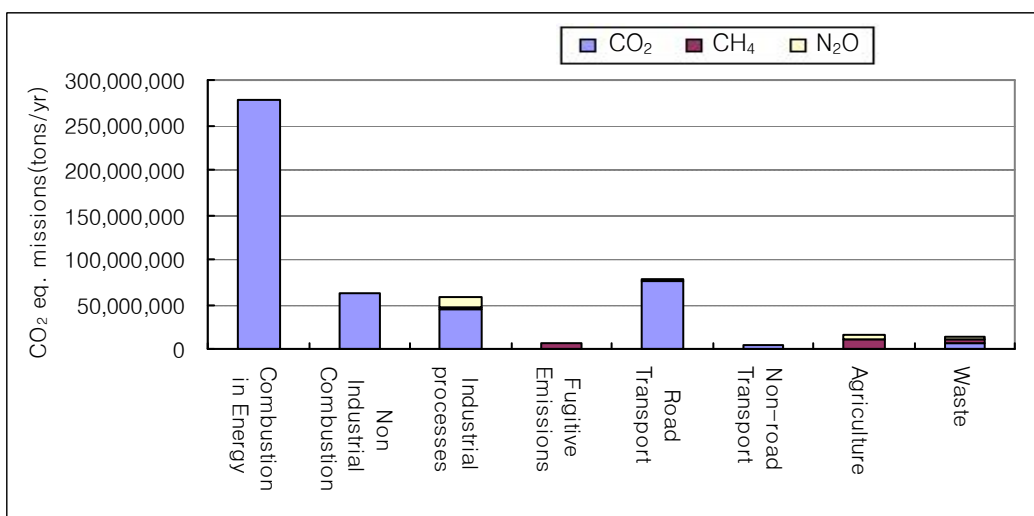
Table 2 shows greenhouse gas emissions by source categories. Combustion in energy production was the main source with emitting 277,205 thousand tons(59%) of total GHG emissions. The other significant sources included road transportation with emitting 74,956 thousand tons(16%), and non-industrial combustion with 61,710 thousands of emission(13%).

<Table 2> GHG emissions by source categories

In tons (CO₂ eq.)

source category	CO ₂	CH ₄	N ₂ O
Combustion in energy production	277,204,445	11,416 (239,736)	3,332 (1,032,920)
Non industrial combustion	61,709,869	18,305 (384,405)	368 (114,080)
Industrial processes	45,183,237	18,714 (392,994)	41,157 (12,758,670)
Fugitive emissions	-	338,974 (7,118,454)	-
Road transportation	74,956,436	8,353 (175,413)	5,593 (1,733,830)
Non-road transportation	5,165,739	167 (3,507)	118 (36,580)
Agriculture	-	578,623 (12,151,083)	7,623 (2,363,130)
Waste	6,191,719	274,585 (5,766,285)	4,014 (1,244,340)
Total	470,411,445	1,249,137 (26,231,877)	62,204 (19,283,240)

* () values are CO₂ eq. emission(GWP : CH₄=21, N₂O=310)

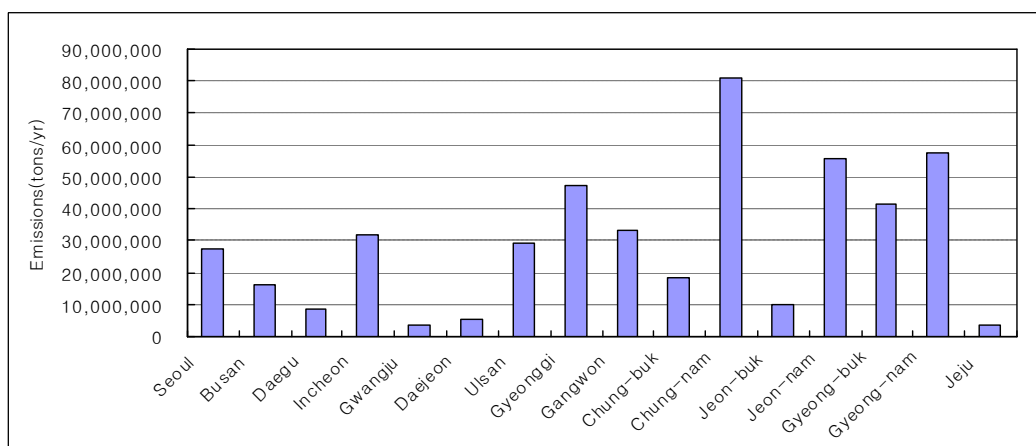


<Figure 2> GHG emissions by source categories, 2006

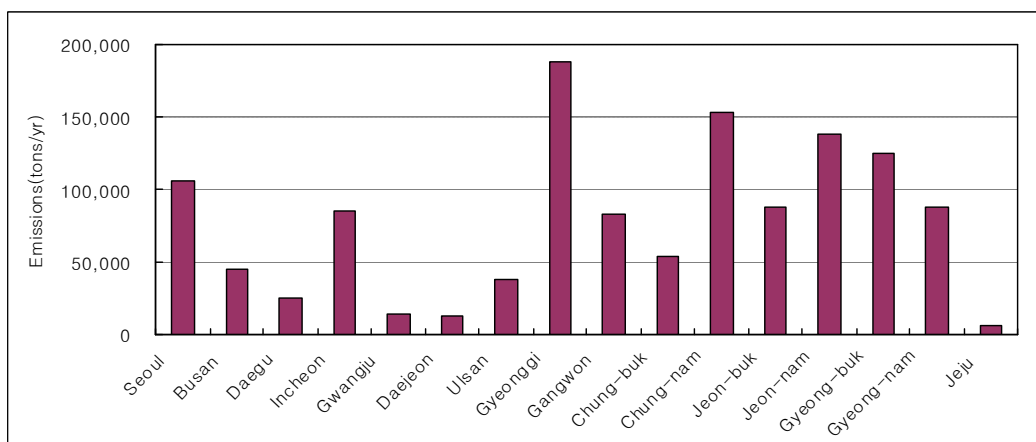
1-2

Emissions Summary by Regions

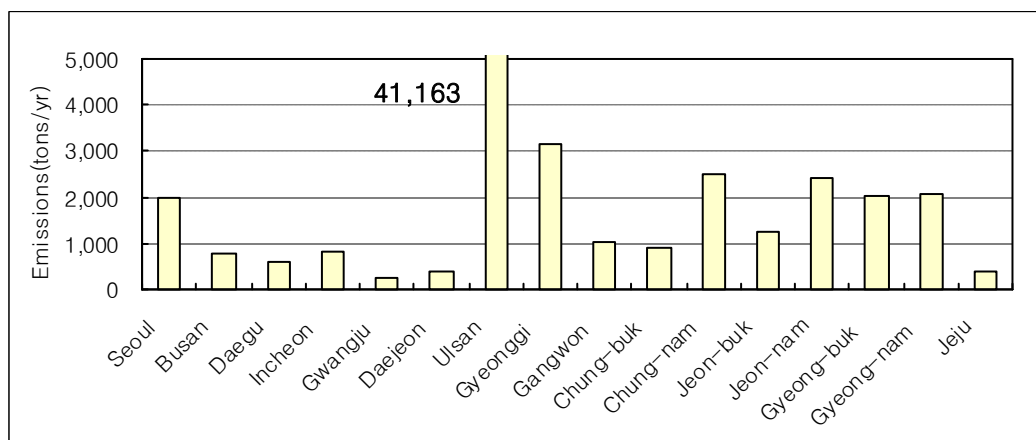
Chung-nam, Jeon-nam, Geong-nam, Gyeonggi recorded the largest emission compared to the other regions. These regions include large sources of CO₂ such as power generation, petroleum refineries, and oil and gas industries.



<Figure 3> CO₂ emissions of cities and provinces, 2006



<Figure 4> CH₄ emissions of cities and provinces, 2006



<Figure 5> N₂O emissions of cities and provinces, 2006

1-3

Spatial Emissions

GHG emissions per capita are estimated as follows, CO₂ 9.6ton/capita, CH₄ 25.6kg/capita, N₂O 1.3kg/capita and all of those increased compared to 2005 year. In case of Metropolitan area, CO₂ emission per unit of capita in 2006 was 4.5ton/capita, CO₂ emission per unit of area was 9,129ton/km².

<Table 3> GHG emission rates by cities and provinces

Unit : ton/yr

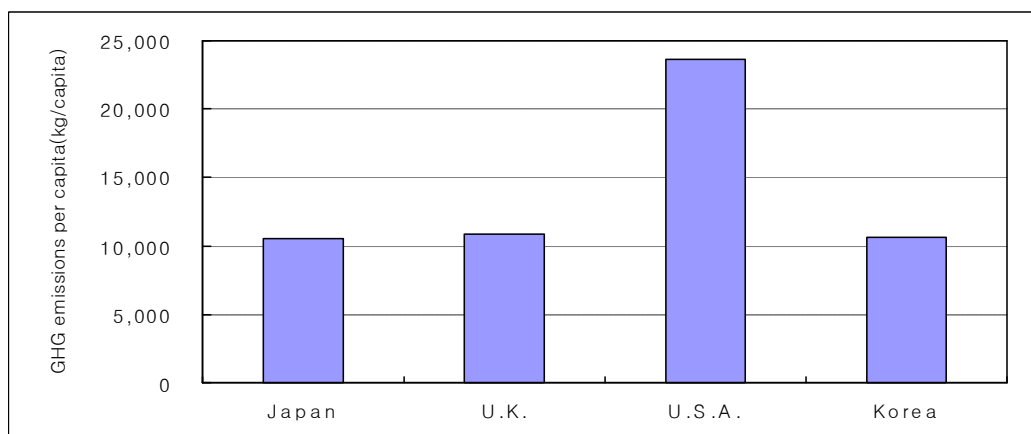
Cities and Provinces	Emissions(ton/year)			Emission rate(%)		
	CO ₂	CH ₄	N ₂ O	CO ₂	CH ₄	N ₂ O
Seoul	27,638,009	105,597	1,995	5.9	8.5	3.2
Busan	16,068,033	45,031	780	3.4	3.6	1.3
Daegu	8,551,146	25,302	597	1.8	2.0	1.0
Incheon	32,144,266	84,894	808	6.8	6.8	1.3
Gwangju	3,498,171	13,782	278	0.7	1.1	0.4
Daejeon	5,232,807	13,425	372	1.1	1.1	0.6
Ulsan	29,379,984	37,545	41,630	6.2	3.0	66.9
Gyeonggi	47,314,260	187,802	3,154	10.1	15.0	5.1
Gangwon	33,150,005	82,515	1,027	7.0	6.6	1.7
Chung-buk	18,583,577	54,151	906	4.0	4.3	1.5
Chung-nam	81,093,483	153,360	2,485	17.2	12.3	4.0
Jeon-buk	9,854,038	87,862	1,260	2.1	7.0	2.0
Jeon-nam	55,644,410	138,028	2,405	11.8	11.0	3.9
Gyeong-buk	41,204,673	125,499	2,043	8.8	10.0	3.3
Gyeong-nam	57,415,821	88,439	2,082	12.2	7.1	3.3
Jeju	3,638,764	5,905	380	0.8	0.5	0.6
Total	470,411,445	1,249,137	62,204	100	100	100

<Table 4> Emissions per capita of the country and the Metropolitan area in 2006

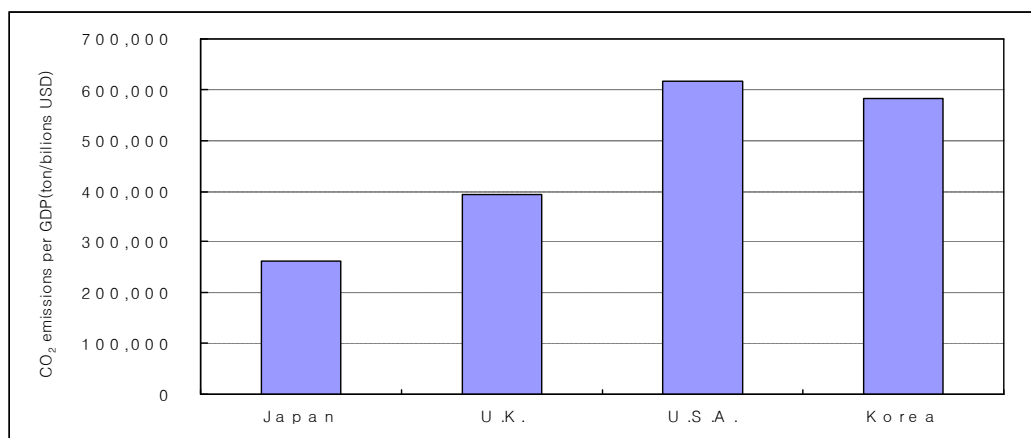
Emissions		CO ₂	CH ₄	N ₂ O
National	Emissions (thousand tons)	470,411.4	1,249.1	62.2
	unit emission by person (tons/10,000 men)	96,462.4	256.1	12.8
	unit emission by area (ton/km ²)	4,723.0	12.5	0.62
Metropolitan	Emissions (thousand tons)	107,096.5	378.3	6
	unit emission by person (tons/10,000 men)	45,274.0	159.9	2.5
	unit emission by area (ton/km ²)	9,129.0	32.2	0.51

According to national GHGs inventory report in the advanced countries, greenhouse gas emissions per capita of Korea reached the level of U.K and Japan. In 2006, GHG emission per capita in Korea is 10,682 CO₂eq. ton/10³ capita which has increased by 4.4% compared to 2001(10,236 CO₂ eq. ton/10³ capita).

In case of U.S, emission is remarkably high as 23,674 CO₂eq. ton/10³ capita due to high energy consumption rate, and 2% decreased compared to 2001. In case of U.K., emissions per capita in 2006 is 10,489 CO₂eq. ton/10³ capita, which is close to emission level in Korea.



<Figure 6> GHG Emissions per capita (CO₂ eq.)



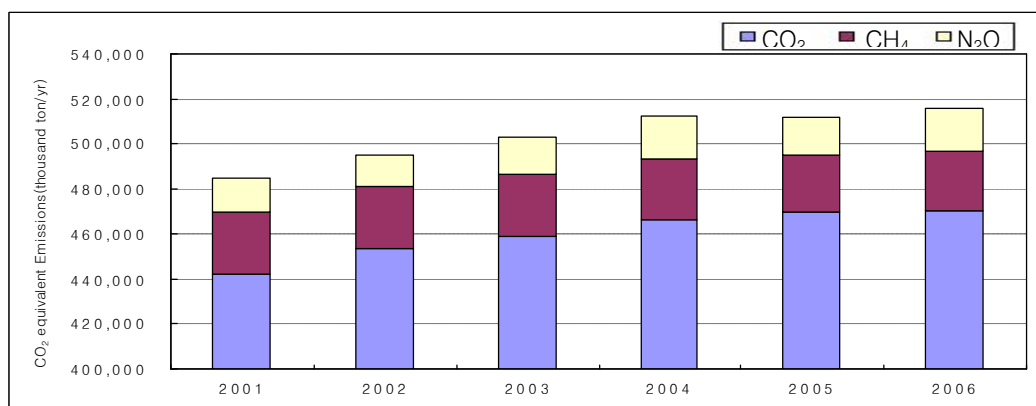
<Figure 7> GHG emissions per GDP (CO₂ eq.)

2. Emission Trends

2-1

Emission Trends by GHGs

Total greenhouse gas emissions have increased from 2001 to 2006. Combustion in energy production is the largest sector in Korea and emission in this sector contributed 55% of total GHG emissions in 2006. Non-road transportation sector has increased by 2005 however, it began to decrease caused by decreasing activities in 2006.



<Figure 8> GHG emission trends from 2001 to 2006

<Table 5> GHG emission trends from 2001 to 2006

Unit : ton/yr

Year \ GHGs	CO ₂	CH ₄	N ₂ O
2001	441,959,476	1,314,084	49,050
2002	453,368,422	1,332,472	43,949
2003	458,936,865	1,304,828	53,738
2004	466,268,961	1,295,064	61,595
2005	469,497,059	1,209,331	53,985
2006	470,411,445	1,249,137	62,204

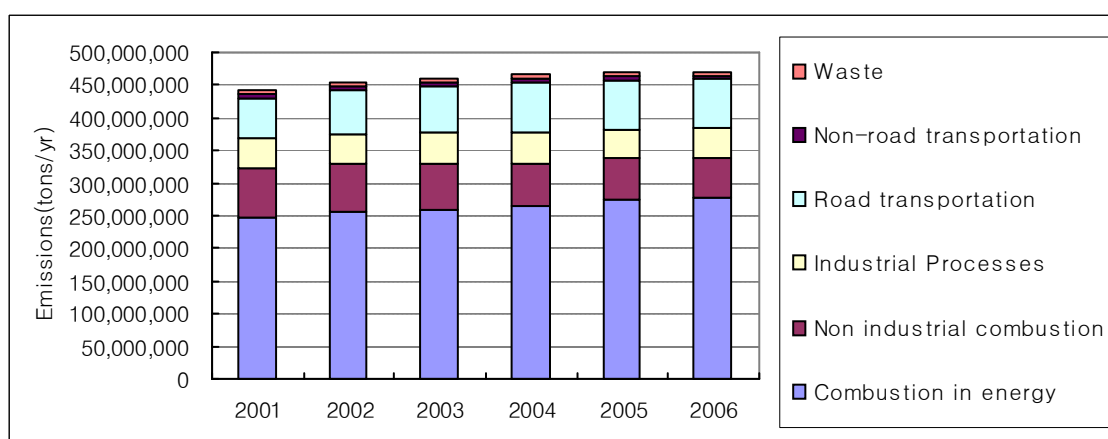
2-1-1. CO₂ emission trends

CO₂ emissions from combustion in energy production accounted for 59% of the total emissions. And, CO₂ emissions from road transportation and waste have also increased every year, by increasing 21% and 28% respectively from 2001. Emissions from non-industrial combustion sector decreased by 20% compared to 2001 and emissions from Industrial process maintained previous level.

<Table 6> CO₂ emission trends by source categories from 2001 to 2006

In 10³ tons

Source category	2001	2002	2003	2004	2005	2006
Combustion in energy	247,449	255,178	259,304	264,890	273,074	277,204
Non industrial combustion	77,108	74,076	69,497	65,296	64,705	61,709
Industrial processes	44,772	45,692	48,230	47,314	44,066	45,183
Road transportation	61,944	67,302	70,583	77,063	75,239	74,956
Non-road transportation	5,849	6,302	6,386	6,354	6,748	5,165
Waste	4,834	4,814	4,933	5,348	5,663	6,191
Total	441,959	453,368	458,936	466,268	469,497	470,411



<Figure 9> CO₂ emission trends by source categories from 2001 to 2006

2-1-2. CH₄ emission trends

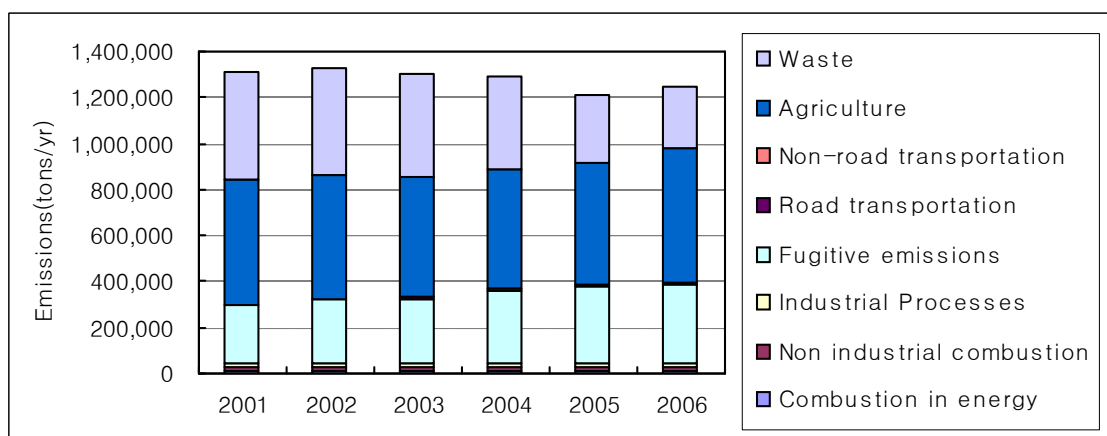
Total CH₄ emission is on an decreasing trend. But emissions from fugitive emissions from fuels and road transportation have increased by 34% and 86% compared to 2001.

Emissions from non-industrial combustion sector have decreased by 2004 then increased from 2005. Industrial process and energy industries combustion sectors show similar emissions annually or slightly increased. Emissions from non-road transportation sector have been constant by 2005 but decreased in 2006. In waste sector, emissions have unchanged by 2004, then began to decrease from 2005. The emission decreased 42% in 2006 compared to 2001.

<Table 7> CH₄ emission trends by source categories from 2001 to 2006

In ton/yr

Source category	2001	2002	2003	2004	2005	2006
Combustion in energy	11,060	11,351	11,565	10,260	11,447	11,416
Non industrial combustion	16,151	15,381	13,728	14,205	17,145	18,305
Industrial processes	16,375	17,152	17,775	17,945	18,435	18,714
Fugitive emissions	252,013	275,480	281,475	314,068	330,783	338,974
Road transportation	4,483	5,691	6,141	7,257	8,061	8,353
Non-road transportation	311	339	345	332	318	167
Agriculture	540,804	536,019	525,876	526,821	527,892	578,623
Waste	472,888	471,059	447,922	404,175	295,250	274,585
Total	1,314,084	1,332,472	1,304,828	1,295,064	1,209,331	1,249,137



<Figure 10> CH₄ emission trends by source categories from 2001 to 2006

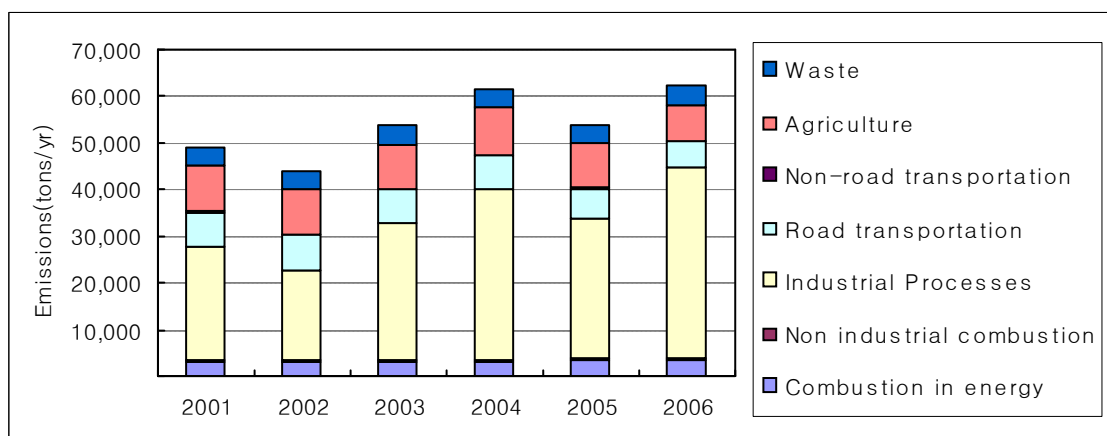
2-1-3. N₂O emission trends

N₂O emissions in waste sectors show similar emissions annually and that from combustion in energy and non-road transportation sectors slightly increased by 12% and 14% in 2006, compared to 2001. Emissions from industrial processes sector decreased by 80% in 2006 compared to 2001. Emissions from non-industrial combustion, road transportation, agriculture sectors also decreased by 25%, 27% and 22% in 2006 compared to 2001.

<Table 8> N₂O emission trends by source categories from 2001 to 2006

In ton/yr

Source category	2001	2002	2003	2004	2005	2006
Combustion in energy	2,956	3,063	3,138	3,186	3,274	3,332
Non industrial combustion	491	465	422	390	391	368
Industrial processes	24,112	19,301	29,360	36,428	30,228	41,157
Road transportation	7,634	7,463	7,101	7,172	6,349	5,593
Non-road transportation	103	110	108	111	125	118
Agriculture	9,756	9,566	9,525	10,298	9,600	7,623
Waste	3,999	3,980	4,084	4,011	4,018	4,014
Total	49,050	43,949	53,738	61,595	53,985	62,204



<Figure 11> N₂O emission trends by source categories from 2001 to 2006

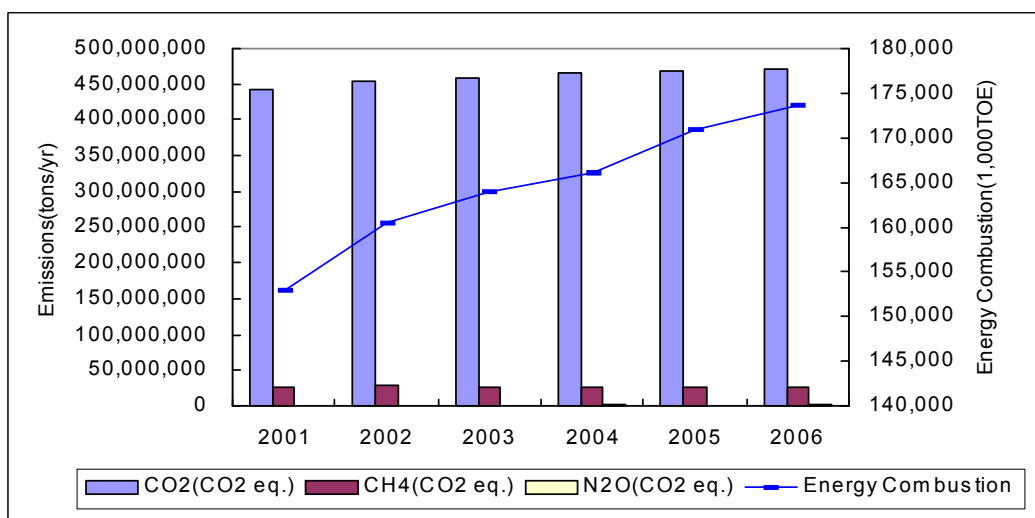
2-2

Summary of National Emission Trends by Activities

In 2006, GHG emissions per GDP is 581,653 CO₂eq. ton/billion USD, which decreased by 42% compared to 2001. GHG emissions per GDP of advanced countries such as U.S, U.K and Japan are 615,015 CO₂eq. ton/billion USD, 262,658 CO₂eq. ton/billion USD, 394,102 CO₂eq. ton/billion USD respectively.

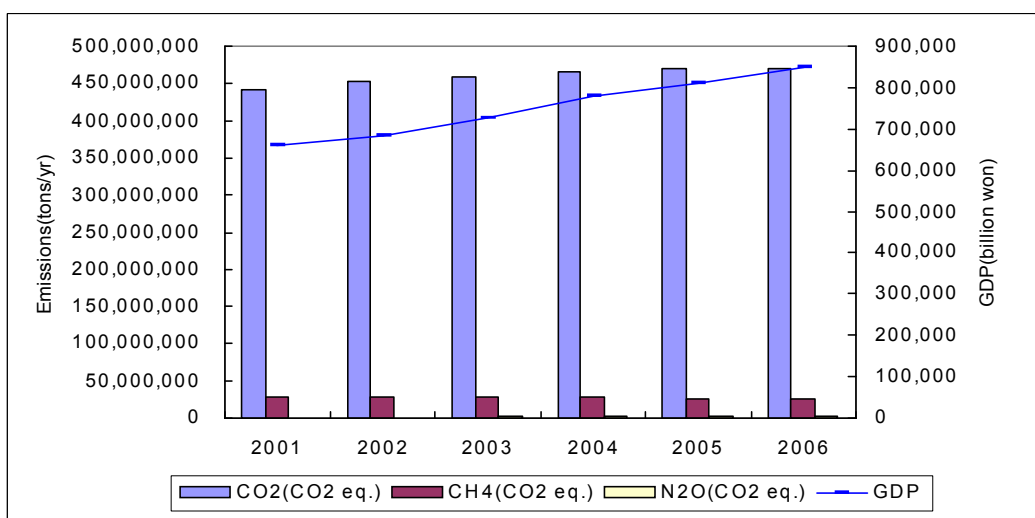
<Table 9> Trends of energy consumption, GDP and GHG emission

		2001	2002	2003	2004	2005	2006
Energy consumption (in thousands of TOE)		152,950	160,451	163,995	166,009	170,854	173,584
GDP (in billions of KRW)		662,123	684,264	724,675	779,381	810,516	847,876
Emissions (tons)	CO ₂	441,959,476	453,368,422	458,936,865	466,268,961	469,497,059	470,411,445
	CH ₄	1,314,084	1,332,472	1,304,828	1,295,064	1,209,331	1,249,137
	N ₂ O	49,050	43,949	53,738	61,595	53,985	62,204



* TOE : tonnage of oil equivalent

<Figure 12> Energy consumption and GHG emission trends



<Figure 13> GDP and GHG emission trends

II. Air Pollutants Emissions

1. 2006 Emissions

1-1

Emissions Summary by Pollutant

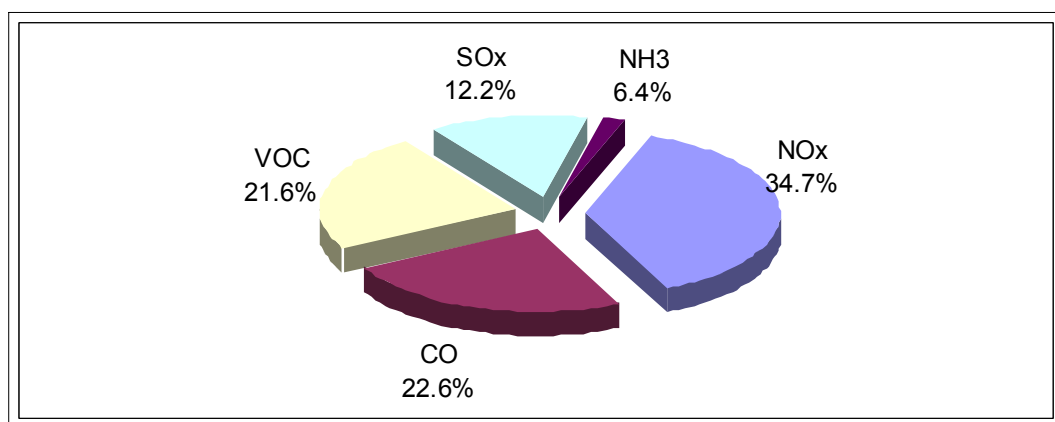
The 2006 emissions in this report are developed using the CAPSS of NIER. Table 10 shows 2006 air pollutant emissions in Korea. NO_x emissions occupied the largest share with 1,275 thousand tons, followed by CO emissions with 830 thousand tons and VOC emissions with 794 thousand tons. Figure 15 shows the contribution rate by air pollutants in 2006.

<Table 10> National air pollutants emissions in 2006

In tons

CO	NO _x	SO _x	PM ₁₀	VOC
829,938	1,274,969	446,488	64,795	794,158

* except fugitive dust and vegetative VOC



<Figure 14> Contribution rate by air pollutants in 2006

Table 11 shows air pollutants emission by source categories. Road transportation was the main source with emitting 1,199 thousand tons(32.7%) of pollutants. The other significant sources included energy industry with emitting 576 thousand tons(15.7%), and solvent utilization with 463 thousands of emission(12.6%).

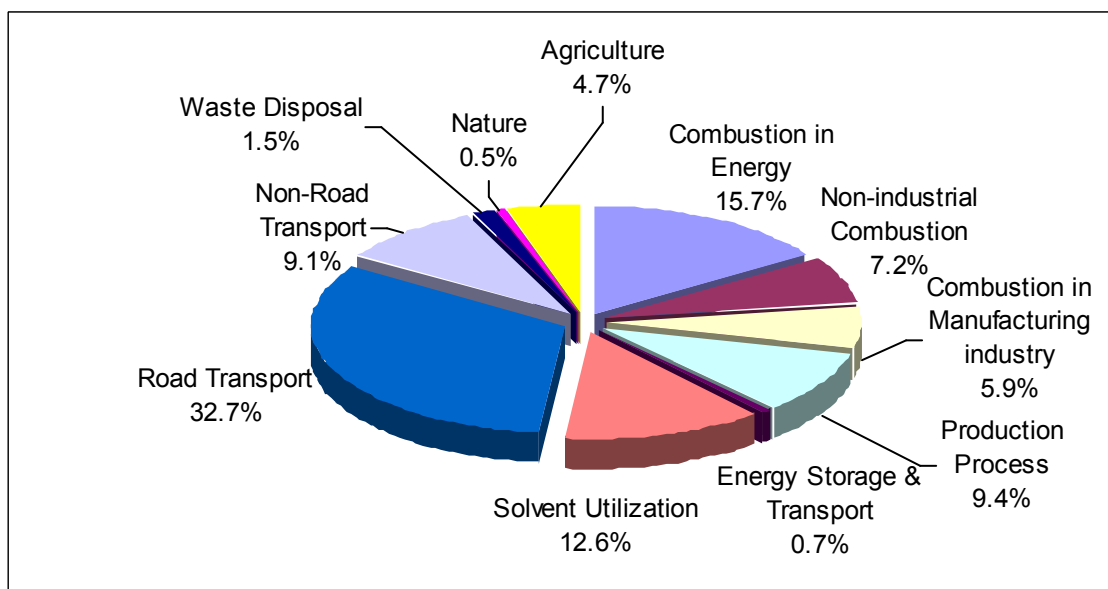
<Table 11> Air pollutants emissions by source categories

In tons

Source category	CO	NOx	SOx	PM ₁₀	VOC
Combustion in energy production	39,290	364,310	152,263	7,701	5,763
Non industrial combustion	88,522	89,127	77,504	3,577	3,046
Combustion in manufacturing industry	13,786	101,197	74,966	14,349	2,298
Production process	21,702	56,577	84,937	6,370	137,123
Energy storage & transport	-	-	-	-	26,124
Solvent utilization	-	-	-	-	463,219
Road transportation	610,762	450,080	1,213	23,911	101,973
Non-road transportation	53,611	196,441	53,926	8,604	19,658
Waste disposal	2,265	17,237	1,679	284	34,953
Nature	-	-	-	-	-
Agriculture	-	-	-	-	-
Total	829,938	1,274,969	446,488	64,795	794,158

CO is mostly emitted from road transportation which amounted to 611 thousand tons(50.9%) and NOx with 450 thousand tons(37.5%), VOC with 102 thousand tons(8.5%). Looking at the energy industry, NOx with 364 thousand tons(63.3%), SOx with 152 thousand tons (26.5%) and CO with 39 thousand tons(6.8%). The solvent utilization is the largest source of VOC. In case of VOC, which is known as the main source of ozone, solvent usage accounted for 58.3 %.

Also PM₁₀ and CO are emitted by road transportation accounted for 36.9% and 73.6%. Road transportation and energy industry(power plant etc.) are most responsible for NO_x with recording emission contribution rate of 35.3% and 28.6%, respectively. SO_x continued downward trend and mostly caused by combustion in energy(34.0%) and manufacturing industry(16.8%). Figure 15 shows contribution rate by source categories in 2006.

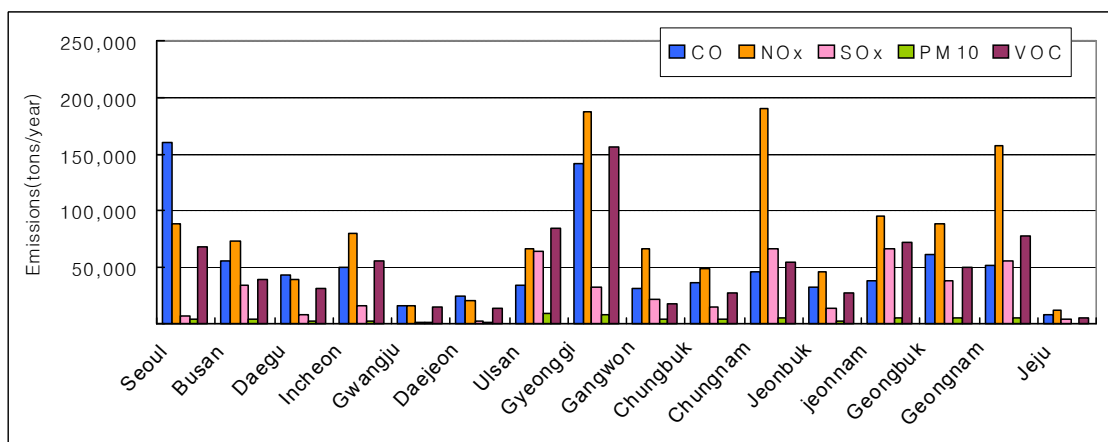


<Figure 15> Contribution rates by source categories

1-2

Emissions Summary by Regions

Gyeonggi-do, Seoul, Gyeongnam-do and Chungnam-do recorded the largest emission compared to the other regions. From metropolitan area, NO_x, SO_x, PM₁₀ and VOC emissions compared to national scale were 355, 55, 15 and 279 thousand tons per year, contributing 27.9%, 12.4%, 22.6% and 35.2%, respectively.



<Figure 16> Air pollutants emissions of cities and provinces, 2006

<Table 12> Emissions and emission rates by cities and provinces

cities and provinces	Emissions(ton/year)				Emission rate(%)			
	NOx	SOx	PM ₁₀	VOC	NOx	SOx	PM ₁₀	VOC
Seoul	87,893	7,276	3,433	68,142	6.9	1.6	5.3	8.6
Busan	73,939	34,356	3,486	38,842	5.8	7.7	5.4	4.9
Daegu	39,325	7,605	2,247	30,692	3.1	1.7	3.5	3.9
Incheon	80,163	16,020	2,566	55,281	6.3	3.6	4.0	7.0
Gwangju	15,768	1,264	706	15,495	1.2	0.3	1.1	2.0
Daejeon	20,184	2,603	833	13,726	1.6	0.6	1.3	1.7
Ulsan	67,243	64,174	8,925	83,683	5.3	14.4	13.8	10.5
Gyeonggi	187,062	32,146	8,660	155,998	14.7	7.2	13.4	19.6
Gangwon	66,449	21,251	4,496	17,797	5.2	4.8	6.9	2.2
Chung-buk	49,068	15,475	3,954	27,563	3.8	3.5	6.1	3.5
Chung-nam	189,818	66,473	5,663	54,707	14.9	14.9	8.7	6.9
Jeon-buk	46,691	12,927	2,560	27,698	3.7	2.9	4.0	3.5
Jeon-nam	94,777	67,017	5,568	72,016	7.4	15.0	8.6	9.1
Gyeong-buk	87,832	38,291	5,907	50,820	6.9	8.6	9.1	6.4
Gyeong-nam	157,125	56,165	5,415	76,774	12.3	12.6	8.4	9.7
Jeju	11,632	3,446	377	4,926	0.9	0.8	0.6	0.6
Total	1,274,969	446,488	64,795	794,158	100.0	100.0	100.0	100.0

* except fugitive dust and vegetative VOC

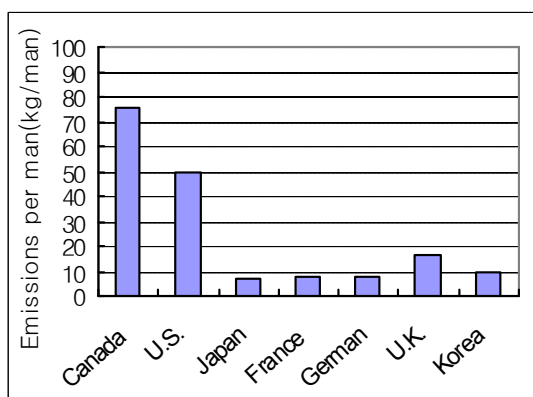
Pollutant emissions per capita are estimated as follows, NOx 26.1 kg/capita, SOx 9.2 kg/capita and PM10 1.3 kg/capita. Among others, Chungnam-do and Ulsan recorded the highest level. Chungnam-do is estimated 96.5 kg/capita in terms of NOx while Ulsan 58.7kg/capita in terms of SOx and 8.2 kg/capita of PM10.

In case of pollutant emissions per area(km^2), metropolitan area was found to emit pollutants more than any other cities because there was densely populated area. In particular, Seoul was the most polluted area in terms of CO(264 ton/km^2) and NOx(145 ton/km^2) due to heavy traffic congestion.

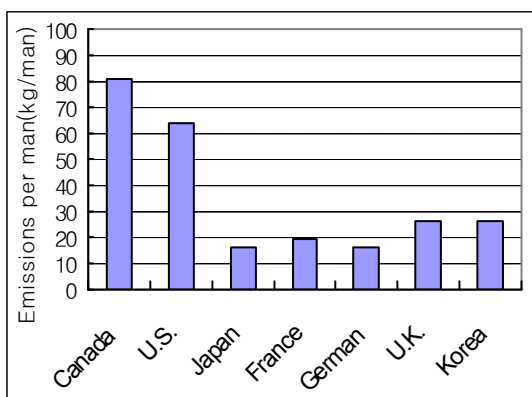
<Table 13> Emissions per 10,000 men of the country and the Metropolitan area

Emissions		CO	NOx	SOx	PM ₁₀	VOC
National	Emissions (thousand tons)	829.9	1,275.0	446.5	64.8	794.2
	unit emission by person (tons/10,000 man)	170.2	261.4	91.6	13.3	162.8
	unit emission by area (ton/km^2)	8.3	12.8	4.5	0.7	8.0
Metropolitan	Emissions (thousand tons)	352.2	355.1	55.4	14.7	279.4
	unit emission by person (tons/10,000 man)	148.9	150.1	23.4	6.2	118.1
	unit emission by area (ton/km^2)	30.0	30.3	4.7	1.2	23.8

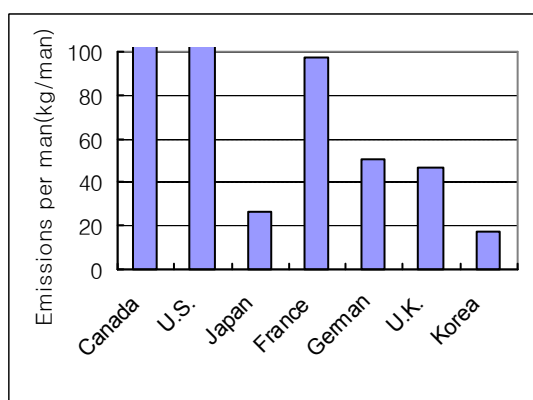
According to 2005 OECD report, pollutant emissions per capita of Korea reached the level of Japan and advanced countries in Europe. Only US and Canada, in which energy consumption extremely high, recorded much higher emission amount than Korea. In detail, NO_x emission was 26.1 Kg/capita which was lower than US(57.3/capita) and Canada (73.6kg /capita) and was similar to the level of European countries. SO_x emission of Korea was 8.9 kg/capita, a lot lower than Canada(64.0kg/capita) and US(44.8kg/capita), because of its successful efforts to reduce SO_x emission.



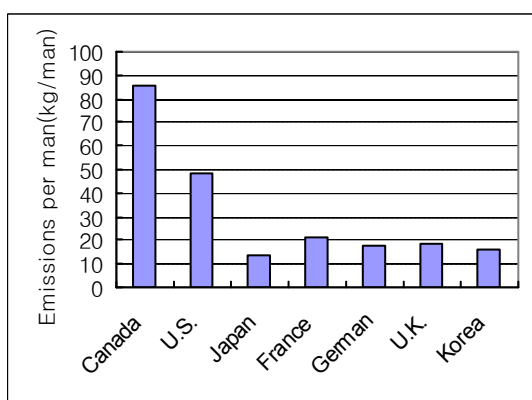
(a) SO_x



(b) NO_x



(c) CO



(d) VOC

<Figure 17> Air pollutants emission per capita

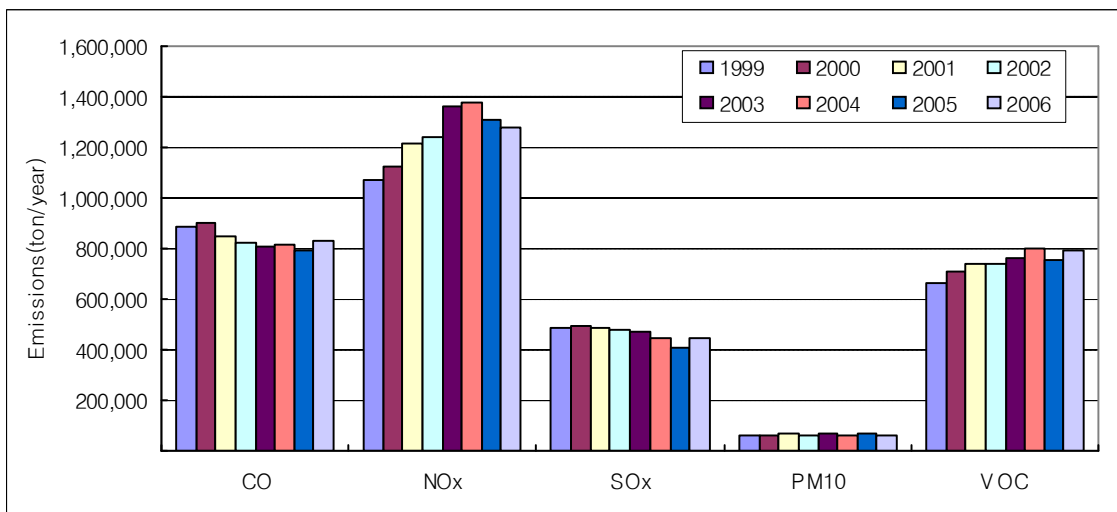
2. Emission Trends

2-1 Emission Trends by Pollutant

NO_x and VOC emissions from road transportation increased from 1999 to 2004. But, NO_x decreased from 2005, while VOC reduced in 2005 and then increased 5.0% in 2006

SO_x emission decreased continuously from 2000 to 2005, due to low-sulfur fuel and LNG supply policy. But, in 2006, SO_x increased by 9.3%.

CO emission went up and down from 1999 to 2005, but increased by 5.2% in 2006. PM₁₀ emission went up and down from 1999 to 2005. And, PM₁₀ decreased by 3.8% in 2006.



<Figure 18> Air pollutants emission trends from 1999 to 2006

<Table 14> Air pollutants emission trends from 1999 to 2006

In tons

Pollutant Year	CO	NOx	SOx	PM ₁₀	VOC
1999	885,179	1,072,323	484,716	63,251	665,043
2000	900,569	1,122,844	490,761	61,719	706,915
2001	845,076	1,219,020	487,734	67,368	734,814
2002	822,767	1,242,265	474,084	65,100	741,647
2003	805,414	1,362,141	469,145	66,357	758,455
2004	816,954	1,377,526	446,804	62,491	797,240
2005	788,917	1,306,724	408,462	67,343	756,421
2006	829,938	1,276,969	446,488	64,795	794,158

* except fugitive dust and vegetative VOC

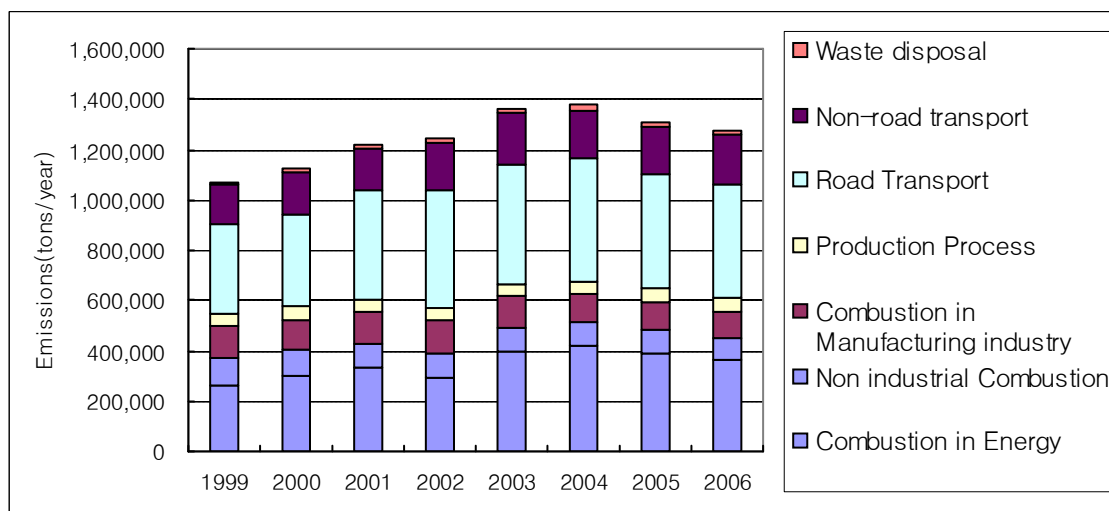
2-1-1. NOx emission trends

NOx emission has increased from 1999 to 2004, but it dropped from 2005. NOx emission source categories are shown in table 15 and figure 19. Major emission sources are combustion in energy and road transportation. Decreasing NOx emission in 2006 seems to be caused by the reduction of the energy consumption in large company and road transportation combustion. Besides, NOx emission from manufacturing industry and non-industrial combustion had went down since 1999 steadily. Meanwhile, emission from combustion in production process climbed up during the same period. And, emission from non-road transport and waste disposal went up and down.

<Table 15> NOx emission trends by source categories from 1999 to 2006

In tons

Source category	1999	2000	2001	2002	2003	2004	2005	2006
Combustion in Energy	264,563	302,627	334,425	296,004	396,070	421,861	390,895	364,310
Non industrial combustion	107,544	98,269	94,791	95,148	94,602	90,781	93,658	89,127
Combustion in Manufacturing industry	128,580	125,097	124,545	127,676	123,221	110,470	108,186	101,197
Production Process	47,045	48,561	50,029	52,780	53,664	53,145	55,327	56,577
Road Transport	352,401	365,242	437,341	462,108	472,245	490,481	455,217	450,080
Non-road transport	159,739	166,360	162,900	190,644	203,583	191,008	188,631	196,441
Waste disposal	12,452	16,687	14,990	17,904	18,755	19,780	14,811	17,237
Total	1,072,323	1,122,844	1,219,020	1,242,265	1,362,141	1,377,526	1,306,724	1,274,969



<Figure 19> NOx emission trends by source categories from 1999 to 2006

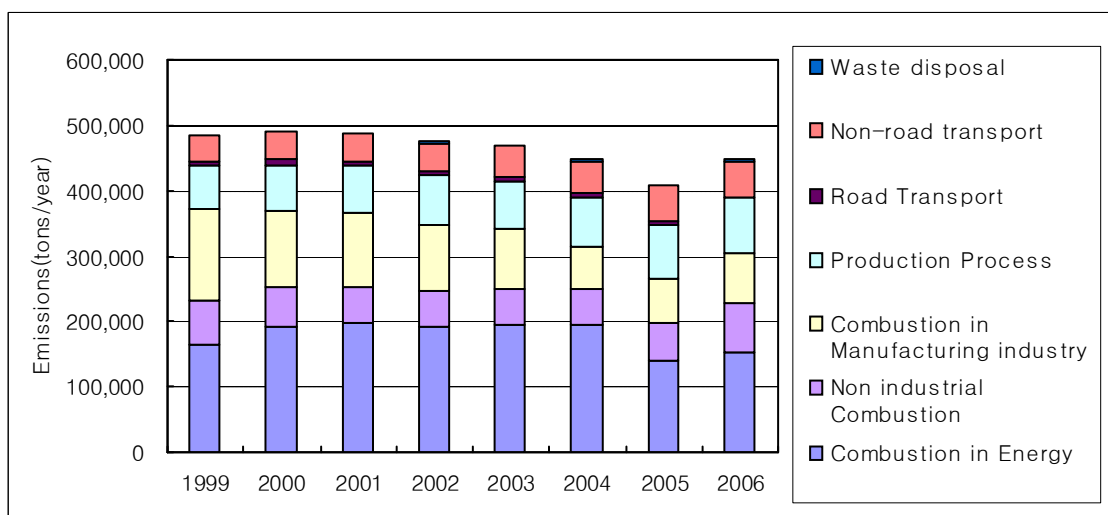
2-1-2. SOx emission trends

SOx emission has decreased from 2000 to 2005. but, it increased in 2006. Table 16 and figure 20 show detail data about SOx emission trends by source categories. SOx emission from energy combustion occupied the maximum share. Emission reduced from 2003 and then increased in 2006. SOx emission of Manufacturing industry has decreased since 1999. But, SOx emission increased from 2005. The reason is increments of sulfur contents in fuel. Emissions caused by road transportation had decreased since 2003, and showed a remarkable decrease in 2006 because of improvements of low sulfur fuel(0.043%→0.003%). For the production process, its emission has increased continuously since 2003, as shipment and energy consumption of the industry increased, especially petrochemical industry and steel manufacturing industries.

<Table 16> SOx emission trends by source categories from 1999 to 2006

In tons

Source category	1999	2000	2001	2002	2003	2004	2005	2006
Combustion in energy	165,723	192,180	197,579	191,750	194,516	194,309	139,064	152,263
Non industrial combustion	65,123	60,231	56,529	54,748	56,087	54,797	58,706	77,504
Combustion in manufacturing industry	139,230	115,880	110,171	100,834	90,324	65,681	68,181	74,966
Production process	67,981	71,648	73,449	74,807	74,028	75,210	82,371	84,937
Road transport	5,742	6,441	7,209	6,309	6,654	6,600	5,190	1,213
Non-road transport	39,755	43,111	41,537	44,210	45,998	48,718	53,506	53,926
Waste disposal	1,161	1,269	1,259	1,426	1,538	1,489	1,444	1,679
Total	484,716	490,761	487,734	474,084	469,145	446,804	408,462	446,488



<Figure 20> SO_x emission trends by source categories from 1999 to 2006

2-1-3. PM₁₀ emission trends

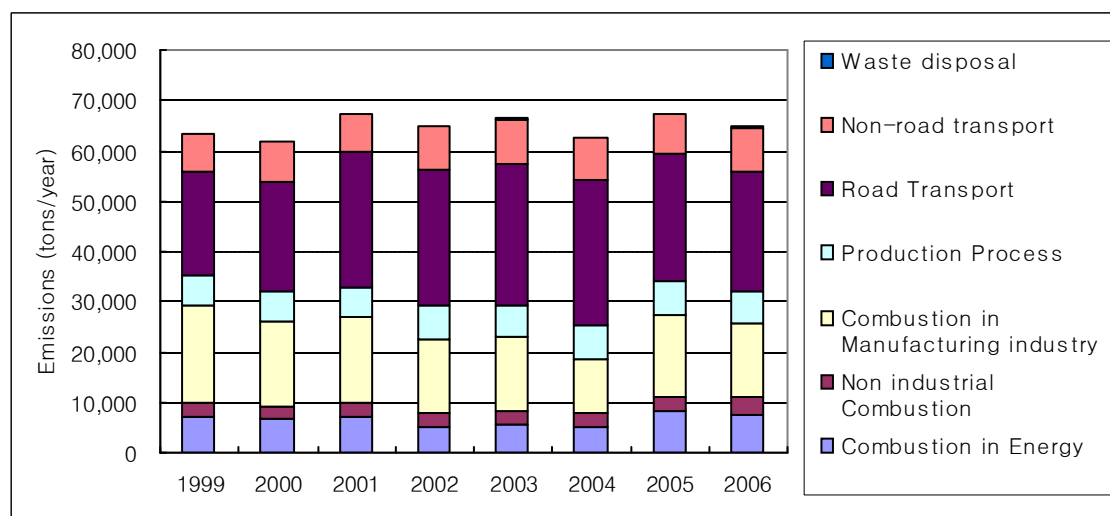
The table 8 and figure 11 show that PM₁₀ emission trends tracked from 1999 to 2006. PM₁₀ emissions went up and down within a range of 62 thousand tons to 67 thousand tons. Major emission sources are road transportation and manufacturing industry. PM₁₀ emission decreased in 2006

<Table 17> PM₁₀ emission trends by source categories from 1999 to 2006

In tons

Source category	1999	2000	2001	2002	2003	2004	2005	2006
Combustion in energy	7,066	6,606	7,263	5,196	5,433	5,032	8,229	7,701
Non industrial combustion	2,763	2,589	2,800	2,665	2,718	2,861	2,978	3,577
Combustion in manufacturing industry	19,619	16,895	16,687	14,881	14,704	10,903	16,000	14,349
Production process	5,667	6,079	6,129	6,378	6,486	6,738	6,888	6,370
Road transport	20,619	21,749	26,795	27,225	27,903	28,898	25,312	23,911
Non-road transport	7,463	7,732	7,630	8,679	9,033	7,977	7,870	8,604
Waste disposal	53	70	63	75	79	82	64	284
Total	63,251	61,719	67,368	65,100	66,357	62,491	67,343	64,795

* except fugitive dust



<Figure 21> PM₁₀ emission trends by source categories from 1999 to 2006

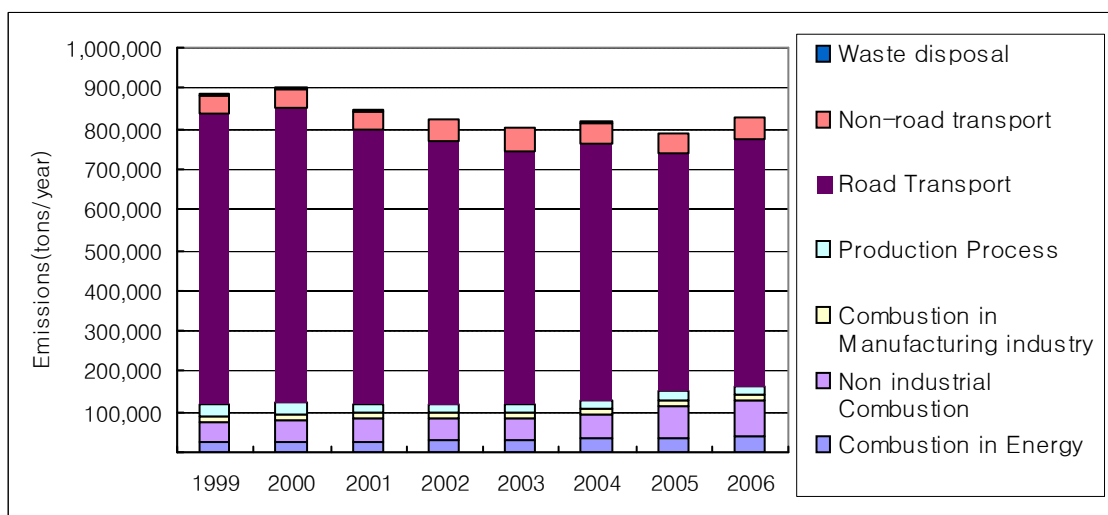
2-1-4. CO emission trends

Following CO emission trends from 1999 to 2006, CO emission in 1999 was 885 thousand tons and decreased to 830 thousand tons in 2006. CO emissions from road transportation which occupied about 73.6% of total CO emissions in 2006 was increasing. In particular, it showed a substantial decrease since 2000 and went up by 4.5% in 2006, compared to the previous year. Although CO emissions from combustion in energy and non-industrial combustion had increased since 2004, but it had limited influences on entire CO emission.

<Table 18> CO emission trends by source categories from 1999 to 2006

In tons

Source category	1999	2000	2001	2002	2003	2004	2005	2006
Combustion in Energy	22,554	24,407	26,732	27,524	28,134	32,522	35,889	39,290
Non industrial combustion	53,714	55,338	56,470	54,791	55,009	60,050	79,759	88,522
Combustion in Manufacturing industry	13,838	14,295	14,300	15,099	14,912	13,867	14,342	13,786
Production Process	29,631	29,204	21,765	21,751	22,022	20,077	22,882	21,702
Road Transport	717,584	727,548	677,180	647,091	625,812	636,938	584,485	610,762
Non-road transport	46,284	48,001	46,895	54,530	57,399	51,415	49,613	53,611
Waste disposal	1,575	1,775	1,734	1,980	2,126	2,085	1,948	2,265
Total	885,179	900,569	845,076	822,767	805,414	816,954	788,917	829,938



<Figure 22> CO emission trends by source categories from 1999 to 2006

2-1-5. VOC emission trends

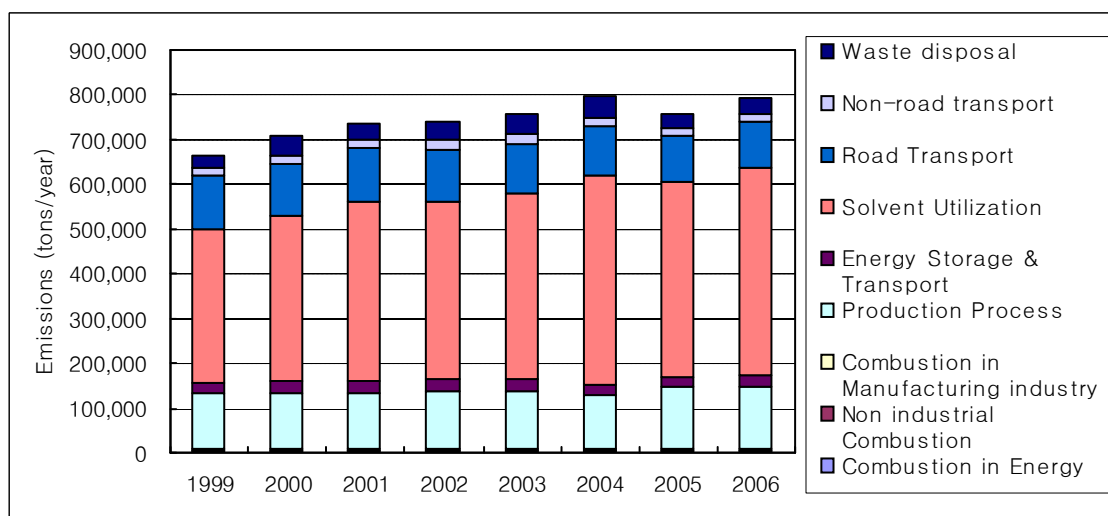
As seen from table 19 and figure 23, VOC emission from solvent utilization for coating went up until 2004, which is similar to total VOC emission trend. But emission reduced in 2005 and then increased by 30 thousand tons in 2006. And, production process and waste disposal had made a contribution to the increases in VOC emission.

<Table 19> VOC emission trends by source categories from 1999 to 2006

In tons

Source category	1999	2000	2001	2002	2003	2004	2005	2006
Combustion in Energy	3,567	3,912	4,235	4,299	4,398	4,885	5,326	5,763
Non industrial combustion	2,571	2,648	2,709	2,851	2,933	2,898	3,041	3,046
Combustion in Manufacturing industry	2,560	2,541	2,536	2,654	2,568	2,378	2,426	2,298
Production Process	124,522	124,136	125,728	128,105	129,498	117,053	134,493	137,123
Energy Storage & Transport	23,938	26,551	26,559	27,169	26,098	25,641	25,933	26,124
Solvent Utilization	342,434	368,199	399,294	396,139	415,559	464,364	432,828	463,219
Road Transport	119,669	119,616	120,845	116,732	111,474	112,435	102,198	101,973
Non-Road Transport	16,713	17,299	16,723	19,836	21,043	19,092	18,461	19,658
Waste disposal	29,068	42,013	36,186	43,862	44,883	48,494	31,715	34,953
Total	665,043	706,915	734,814	741,647	758,455	797,240	756,421	794,158

* except vegetative VOC

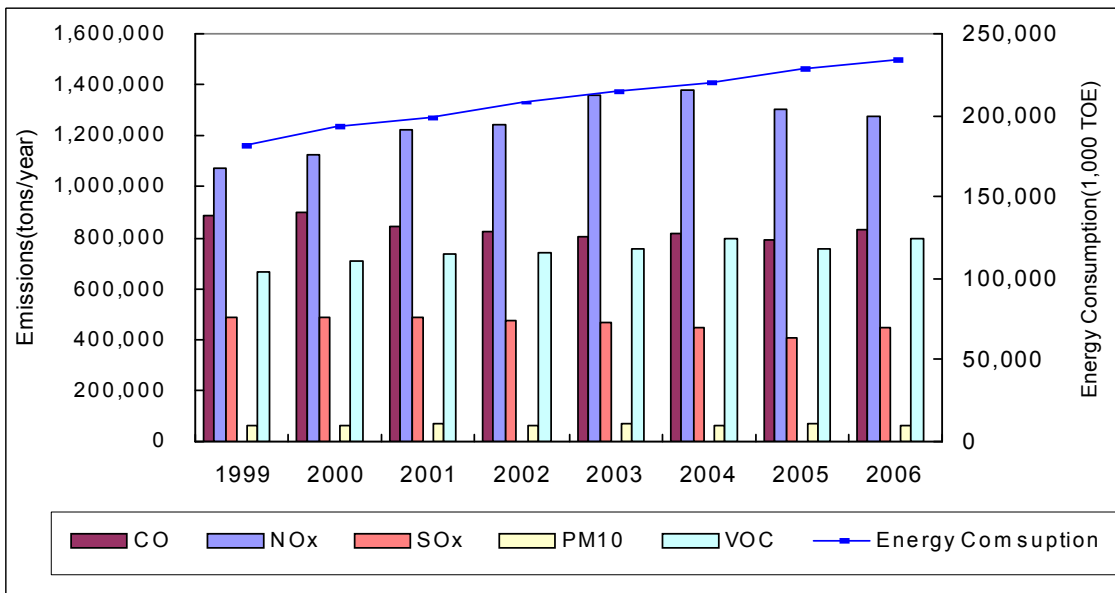


<Figure 23> VOC emission trends by source categories from 1999 to 2006

Energy consumption and GDP go up sharply every year because of increasing population and industrial growth in Korea. However, SOx emission trends differ from developments of GDP or energy consumption mainly because of strong air pollution control policies of Korea. NOx and VOC follow similar path with GDP and energy consumption. Particularly, combustion in energy is directly related to NOx emissions. Thereby, Korea needs to strengthen its efforts to control them. And area sources must be managed in a more efficient manner to reduce VOC emissions.

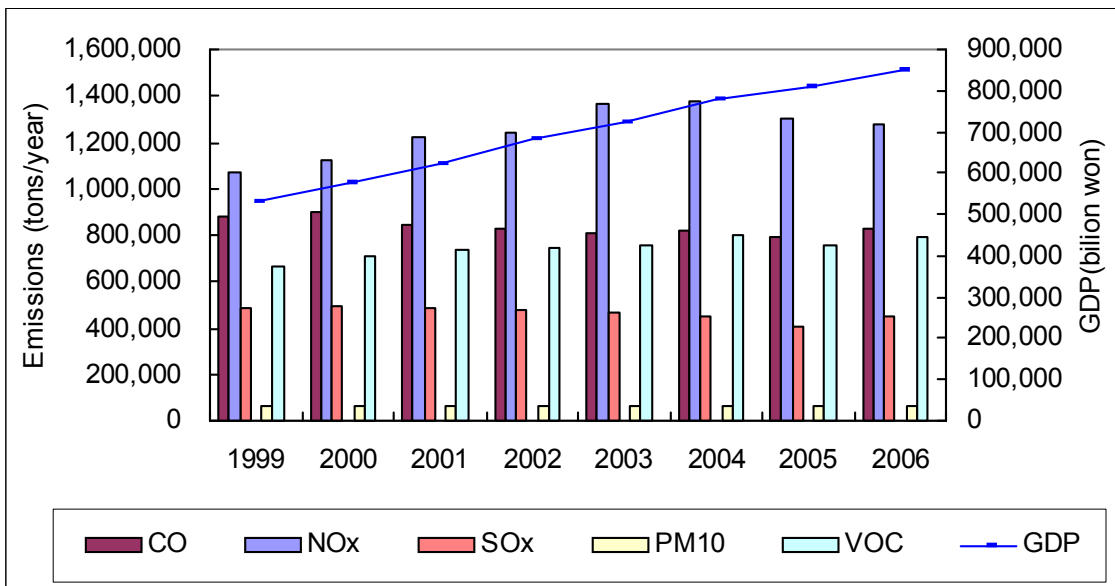
<Table 20> Trends of energy consumption, GDP and pollutant emission

Contents		1999	2000	2001	2002	2003	2004	2005	2006
Energy consumption (in thousands of TOE)		181,363	192,887	198,409	208,636	215,067	220,238	228,622	233,372
GDP (in billions of KRW)		529,500	578,665	622,123	684,264	724,675	779,381	810,516	848,045
Emissions (tons)	CO	885,179	900,569	845,076	822,767	805,414	816,954	788,917	829,938
	NOx	1,072,323	1,122,844	1,219,020	1,242,265	1,362,141	1,377,526	1,306,724	1,274,969
	SOx	484,716	490,761	487,734	474,084	469,145	446,804	408,462	446,488
	PM ₁₀	63,251	61,719	67,368	65,100	66,357	62,491	67,343	64,795
	VOC	665,043	706,915	734,814	741,647	758,455	797,240	756,421	794,158



* TOE : tonnage of oil equivalent

<Figure 24> Energy consumption and pollutants emission trends



<Figure 25> GDP and pollutants emission trends

2006 Greenhouse Gas and Air Pollutants Emissions in Korea

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