CHAPTER II: NATIONAL GREENHOUSE GAS INVENTORY

II. 1. INTRODUCTION

The core elements of the national communications for both Annex I and non- Annex I Parties encompass information on emissions and reductions of greenhouse gases (GHGs), as well as details of the activities undertaken to implement the Convention. The data and procedures need to be consistent, transparent and well documented to the most possible extent.

In the inception report data sources were identified. They entailed Egyptian governmental institutions as well as reputable international data sources. The identified Egyptian institutions are ones responsible for with primary data collection and archiving, such as CAPMAS, information centers and information banks, as well as governmental institutions issuing licenses to targeted entities relevant to the GHG inventory. These licenses include essential technical information about capacity, technology, raw materials and fuel consumptions. Data used in this chapter pertain to activities of the year 2005, unless otherwise indicated. In the methodology for the current GHG inventory, the data received from the sources are reliable with minimum uncertainty. Processing is based on the considered IPCC default methodologies and default emission factors (IPCC, 1996; IPCC, 2000). In consequence, information in this chapter can be classified as falling within the Tier 1 level.

Estimating the GHG emissions in all sections of this chapter is carried out following the default methodology of the "Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories" (IPCC, 1996) and the "Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories" (IPCC, 2000). GHG emissions due to energy used in any sector including industry are calculated in the energy sector. GHG emissions in the industry sector are only emissions due to industrial processes. All calculations in the present report use the Global Warming Potential (GWP) of GHGs for 100 years, of table 2.9 of the "IPCC Second Assessment Report", following the incorporation of the provisions of decision 14/CP.11 for updated UNFCCC reporting guidelines on annual inventories, FCCC/SBSTA/2006/9 18 August 2006.

In cases where data are available, specific site calculations are considered, and the methodologies followed strictly adhere to the well-established scientific and technical rules. Comparison and verification between specific site calculations and the default emission factors defined by the IPCCC is shown. For these cases, the work can be considered as higher than Tier 1. Estimates have been made for the base year 2005. For cases where data are available for the sector and the source category, estimates are carried-out for the time series 1999-2012.

In accordance with paragraph 23 of Decision 17/CP.8, details of the GHG inventory studies are delivered as references, in both electronic and hard copy formats, with the present report of Egypt's Second National Communication to the COP secretariat. Sectors, as sources of GHG emissions, are categorized according to their percentage share in the national GHG inventory. The outline of Egypt's total GHG inventory in the year 2000 is presented by GHG type and also by sector. The national sources of GHGs are presented in successive ordering according to their categories. Data sources for each sector are defined, followed by a summary for the whole country. Whenever data are available, yearly GHG emission series are presented.

II. 2. ELEMENTS OF EGYPT'S GHG INVENTORY

II. 2.1 Egypt's GHG emissions by gas type for the year 2005

Table (II.1) and figure (II.1) present Egypt's total GHG emissions by gas type, for the year 2005.Emissions for the year 2000 are also shown in table (II.1). The total GHG emissions of Egypt in 2005 are 247.98 Mt CO_2e.

Table (II.1): Egypt's GHG emissions by gas type for the years of 2000 and 2005.

Gas	Emission (Mt CO_2e)	Emissions (%)	Emission (Mt CO_2e)	Emissions (%)
	2000		2005	
CO_2	128.2	66.3	167.6	67.58
CH_4	39.4	20.4	35	14.11
N_2O	24.4	12.6	28.74	11.59
PFC	1.1	0.6	1.07	0.43
SF_6	0.1	0.05	0.1	0.04
HFC's blend	0.1	0.05	15.46	6.24
TOTAL	**193.3**	**100**	**247.97**	100

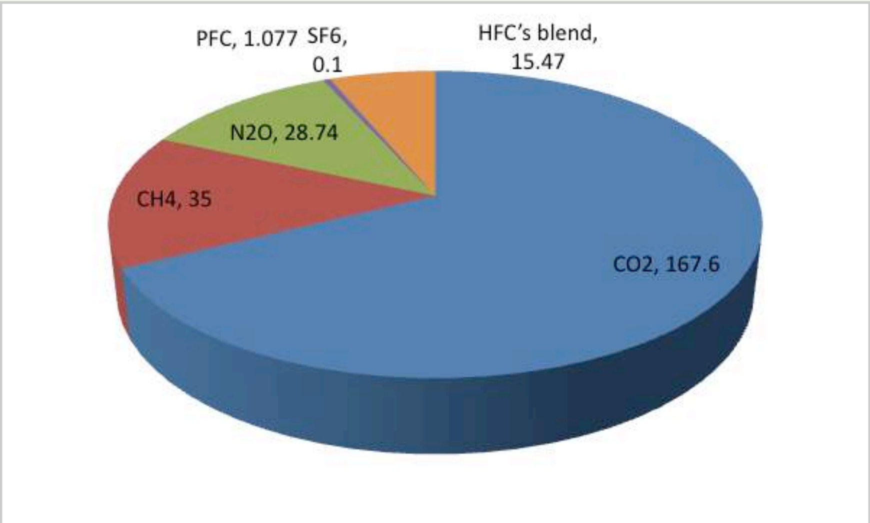


Figure (II.1): Egypt's GHG emissions by gas type for 2005 in Mt CO2e

II. 2.2 Egypt's GHG emissions by sector for the year 2005.

Table (II.2) presents Egypt's total GHG emissions by sector for the year 2005 in comparison with last inventory of 2000. Figure II.2 shows GHG emissions by sector for the year 2005.

Table (II.2): Egypt's GHG emissions by sector for the years of 2000 and 2005

Sector	Emission (Mt CO_2e)	Emissions (%)	Emission (Mt CO_2e)	Emissions (%)
	2000		2005	
Fuel Combustion	105.5	55	-	-
Fugitive Fuel Emissions	10.8	6	-	-
All Energy (Combustion and Fugitive emissions)	116.3	61	147.32	59.4
Agriculture	31.7	16	39.45	16
Industrial Processes	27.8	14	42.01	17
Waste	17.5	9	19.19	7.6
TOTAL	**193.3**	**100**	**247.97**	**100**

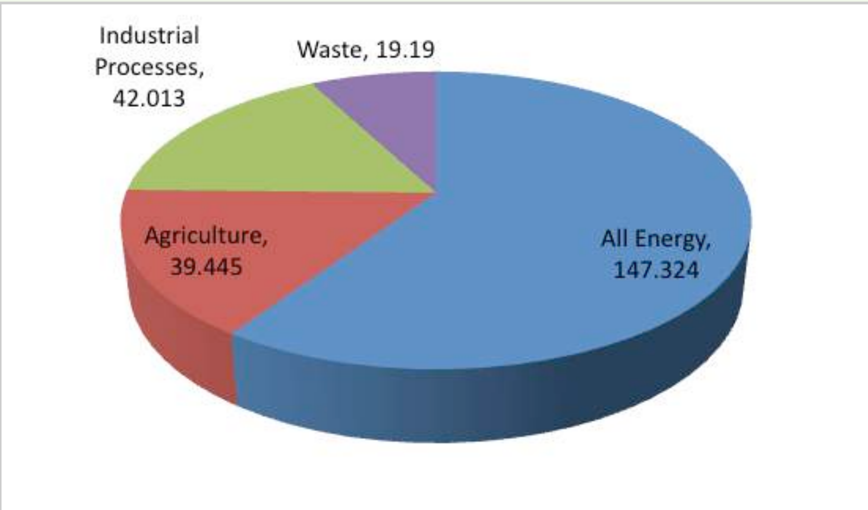


Figure (II.2):Egypt's GHG emissions by sector for 2005 in Mt CO2e

Table (II.3) show the change of sectors' contribution to Egypt's total inventory. It is clear that the total GHG emissions of Egypt increased in 2005 to be 213% of that in 1990 and 128% of that in 2000. During this period from 1990 to 2000, Egypt's population increased by 123% and 136% for period of 1990 to 2005 (Table (II.4)).

Table (II.3): Changes in contributions to the GHG inventory of different sectors

Sector	Emissions (Mt CO_2e/year) & (% of total)						Emissions of 2005 relative to	
	1990		2000		2005		1990%	2000%
All Energy (Combustion and Fugitive emissions)	82.7	71	116.3	61	147.32	59.4	178	126
Agriculture	10.3	9	27.8	14	39.45	16	408	151
Industrial processes	17.9	15	31.7	16	42.01	17	220	124
Waste	5.7	5	17.5	9	19.19	7.6	337	110
TOTAL	**116.6**	**100**	**193.3**	**100**	**247.97**	**100**	**213**	**128**

Table (II.4) gives the change of the GHG indicators for the year 2005 compare with 2000 and those of 1990. Total emissions per capita increased from 2.2 to 3.1 to 3.5tons CO_2e, for 1990, 2000 and 2005, respectively, and the total emissions per thousand US$ of the GDP at market prices decreased from 3.3 tons (1990) to 1.9 tons (2000) and then increase again in 2005 to 2.7tons CO_2e/1000 US$.

Table (II.4): Changes in the total GHG indicators

Year	Population (million)	GDP market price (billion US$)	Emissions (Mt CO2e)	Emissions (ton CO2e/ capita)	Emissions per capita; ratio for 2005/2000/1990 (%)	Emission (ton CO2e/ 1000 US$)	Specific emission; ratio for 2000/1990 (%)	Specific emission; ratio for 2005/2000 (%)
1990	52.6	35.16	116.6	2.2	--	3.3	--	--
2000	63.3	99.74	193.3	3.1	137	1.9	58	
2005	71.78	89.69	245.2	3.5	111	2.76	--	79

II. 3. GHG INVENTORY BY SECTOR

II. 3. 1. The Energy Sector

Energy systems in Egypt are largely driven by the combustion of fossil fuels. During combustion, the carbon and hydrogen of the fossil fuels are converted mainly into carbon dioxide (CO_2) and water (H_2O), releasing the chemical energy in the fuel as heat. This heat is generally either used directly or used (with some conversion losses) to produce mechanical energy, often to generate electricity oris used for transportation. The energy sector is usually the most important sector in greenhouse gas emission inventories. CO_2 accounts typically for more than 95 percent of energy sector emissions with methane and nitrous oxide responsible for the balance. Stationary combustion is usually responsible for about 70 percent of the greenhouse gas emissions from the energy sector. About half of these emissions are associated with combustion in energy industries mainly power plants and refineries. Mobile combustion (road and other traffic) causes about one quarter of the emissions in the energy sector. The energy sector mainly comprises:

- Exploration and exploitation of primary energy sources;
- Conversion of primary energy sources into more useable energy forms in refineries and power plants;
- Transmission and distribution of fuels; and
- Use of fuels in stationary and mobile applications.

II. 3. 1. A. METHODOLOGICAL APPROACH AND DATA SOURCES

Emissions arise from these activities by combustion and as fugitive emissions, or escape without combustion. For inventory purpose, GHGs emissions are calculated according to the following methodology. The approach used in this emissions inventory is based on the following:

1. All sources and sinks, as well as all gases as mandated by 17/CP8, have been covered.
2. Estimates have covered three of the direct GHGs, namely: CO_2, CH_4 and N_2O for both the all energy consumption and the electricity generation for years 1991/1992-2005/2006. Also, indirect GHGs gas of NOx has been covered for the electricity sector only.
3. Used methodologies, assumptions and data were dependent on IPCC 1996 and 2006 guidelines, as appropriate.
4. Source categories are identified for level analysis.
5. Activity Data:

   5.1 Fuel Definitions: The definitions used are the same as the definitions provided by the 2006 IPCC guidelines.

5.2 Fuel Units: For energy statistics and other energy data compilations, production and consumption of solid, liquid and gaseous fuels are specified in physical units, e.g. in tonnes or cubic meters. To convert this data to common energy units, e.g. Joules, net calorific values have been used expressed in SI units, as per 2006 IPCC guidelines for national greenhouse gas inventories.

6. Reliable activity data for the Energy Sector were used. Reliance has been put on sector data as given in the national sectoral reports, i.e. reports of the Egyptian General Petroleum Corporation (EGPC), the Egyptian Gas Holding Company (EGAS) and the Egyptian Electricity Holding Company (EEHC).
7. Emission factors that have been used in estimating emissions inventory relied on the IPCC good practice guidance issued in the years 1996 and 2006.
8. Uncertainty analyses were conducted for the energy inventory. These uncertainty estimates were conducted as given in the “IPCC Good Practice Guidance”. Tier 1 uncertainty analysis was conducted.
9. Emissions released from bunker fuels were not estimated.
10. Estimates have been made for the base year 2005/2006. Also, estimates were carried out for All Energy Consumption for the time series 1991/1992-2005/2006 and for Electricity Generation for the time series of the same period in order to provide a clear view of the emissions trend.
11. The Energy Inventory of GHGs emissions and sinks for Egypt has been compiled for the fiscal years 1991/1992 through 2005/2006 (Fiscal year starts 1stJuly of a specified year and ends 30th of June the next year). The base year was 2005/2006. The five years period was selected for trend illustration.

The GHGs emissions from all energy consumption were calculated based on the following:

1. The Tier I method presented in the 2006 IPCC guidelines for estimating emissions from fossil fuel combustion has been used.
2. The Tier II method requirements, presented in the 2006 IPCC guidelines, have been almost met for the energy sector.
3. Emissions from all sources of combustion have been estimated on the basis of the quantities of fuel combusted (basically from national energy statistics) and using average emission factors.
4. Emission factors for CO_2 depend on the carbon content of the fuel, combustion conditions are relatively of a minor importance.
5. Local consumption has been estimated for Production ***plus*** Imports ***minus*** Exports ***plus or minus*** Stock Change.

   Simple equation has been used as follows:

   Local Consumption = Production + Imports – Exports + Stock Change
6. Other petroleum products such as wax, lubricating oils, bitumen …etc. have been considered as non-

energy use, hence, they were not considered in CO_2, CH_4, N_2O and NO_x, emissions calculations.

7. Natural gas utilized in fertilizer industry is considered as raw materials; hence it is not considered is calculating CO_2 emissions.
8. CH_4 default emission factor described in Vol. 1.2 under the title: “Energy”, Table 2.2 (energy industries) has been used.
9. N_2O default emission factor described in Vol. 1.2 under the title: “Energy”, Table 2.2 (energy industries) has been used

As for annual GHGs emissions from electric power generation, it based on the following:

- Emissions have been designed according to the IPCC 1996 and 2006 guidelines.
- Default factors of emissions for each GHGs emission category have been used as per the IPCC guidelines.

Global Warming Potential (GWP) Calculation Method based on the Annual Statistical Reports of the Egyptian Electricity Holding Company (EEHC) and the National Dispatch Center for checking and discussing data , was used. The following steps have been undertaken for calculating the GHGs emissions from electricity generation:

- Annual fossil fuel consumption of each single power plant has been identified for each type of fossil fuel, i.e. natural gas, mazout (fuel oil no. 6), gas oil/diesel (fuel oil no. 2), and special gas oil/diesel (imported fuel oil no. 2).
- Tables for calculating GHGs of the specified GHGs have been used as per the IPCC Third Report, 2001.
- All specified steps provided by the IPCC guidelines for calculating GHGs emissions have been precisely followed.

All relevant data have been collected from its respective sources, i.e. Egyptian General Petroleum Corporation (EGPC), Egyptian Natural Gas Holding Company (EGAS), Egyptian Electricity Holding Company (EEHC), New and Renewable Energy Authority (NREA), Ministry of Planning, Ministry of Transport, etc. In addition, interviews with key persons and visits to the concerned authorities/ institutions for consultation on methodology, in addition to analysis and review of the above mentioned reports and provision of specific information on energy per each fuel cycle, i.e. from exploration to end use, have been accomplished. Concerned consulted authorities / institutions include the following:

- Ministry of Petroleum.
- Ministry of Electricity & Energy.
- Egyptian General Petroleum Corporation (EGPC).
- Egyptian Natural Gas Holding Company (EGAS).

- Egyptian Electricity Holding Company (EEHC).
- National Electricity Dispatch Center (NDC).

II.3.1.B. EMISSIONS FROM THE FUEL COMBUSTION AND ELECTRICITY

Emissions of CO2e from the energy sector for the base year 2005/2006 are 147,324 Gg. Emissions of CO2e from the Electricity Sector for the base year 2005/2006 are 54,845 Gg. - The percentage of GHGs emissions of the Electricity Sector relative to all energy consumption for CO2e for the base year 2005/2006 is 37.23%.

GHGs Emissions from All Energy Consumption for the Base Year 2005/2006 are:

- GHGs Emissions from All Energy Consumption by GHGs Gases.
- GHGs Emissions from All Energy Consumption by Energy Types/ Products.
- GHGs Emissions from All Energy Consumption by Source Categories/Sectors.
- Fugitive Emissions.

Table (II.5)and figure (II.3) present details of emissions by type of gas for the base year 2005/2006 resulting from fuel combustion. It is clear that carbon dioxide emissions represent more than 99% of the total CO_2e of the total GHG emissions. The combustion of petroleum fuel represent 53% of the total GHG emissions of the energy sector while the natural gas account for about 47% as shown in figure (II.4).

Table (II.5):.GHGs emissions from all energy consumption by gas Type, 2005/2006 in million tons/year

GHGs	Petroleum	Natural Gas	Total	Total CO_2e	Share of Total (%)
CO_2	78.175	69.003	147.178	147.178	99.90%
CH_4	0.00289	0.00123	0.00412	0.095	0.06%
N_2O	0.00012	0.00006	0.00018	0.052	0.04%
CO_2e*	**78.275**	**69.050**	**147.324**	**147.324**	**100.00%**
Total (%)	**53.13%**	**46.87%**	**100.00%**		

* CO_2e = CO_2 Equivalent according to the IPCC's third report, 2001.

* GWP (Global Warming Potential): CO_2 = 1 &CH_4=23& N_2O = 296

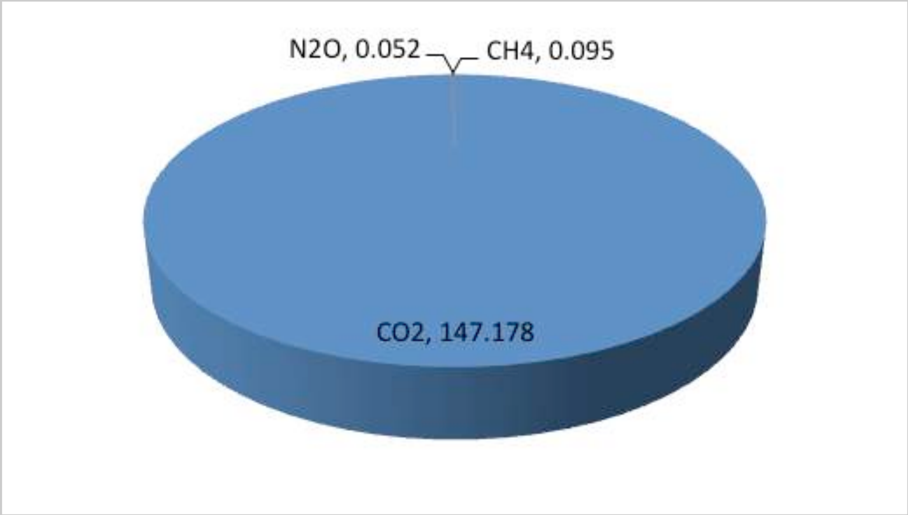


Figure (II.3): GHG emissions from energy consumption by gas type in Mt CO2e, 2005/2006

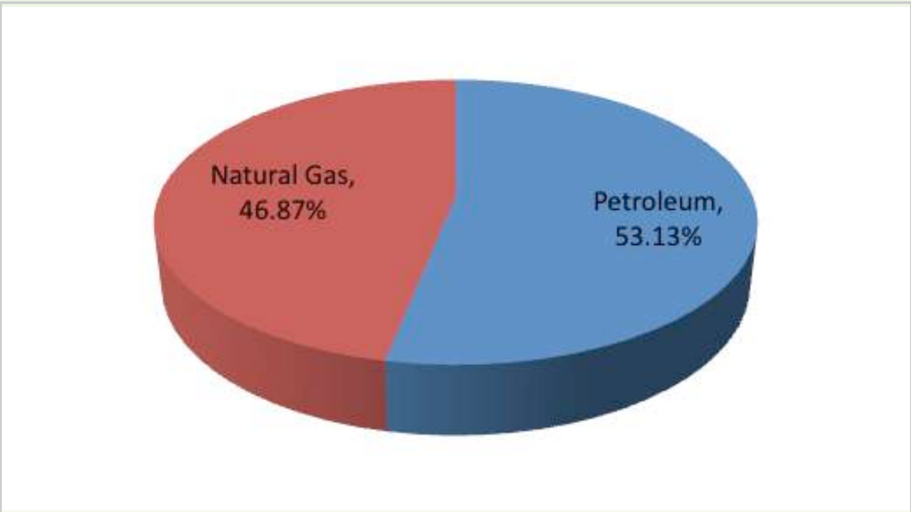


Figure (II.4): GHG emissions from petroleum fuels and natural gas, 2005/2006

Table (II.6) and figure (II.5) represent GHG emissions by fuel type for the energy sector.

Table (II.6): GHGs emissions from all energy consumption by fuel type in thousand tons/ year, 2005/2006

GHGs	LPG	Gasoline	Kerosene/ Turbine	Gasoil/ Diesel	Fuel Oil	Total Petroleum	Natural Gas	Grand Total
CO_2	10575	9063	2434	31031	25072	78175	69003	147178
CH_4	0.167	0.393	0.101	1.256	0.970	2.287	1.230	4.117
N_2O	0.018	0.014	0.004	0.044	0.034	0.114	0.062	0.175
CO_2e*	10583	9075	2437	31073	25104	78274	69049	147324

* CO_2e = CO_2 Equivalent according to the IPCC's third report, 2001.

* GWP (Global Warming Potential) : CO_2 = 1 & CH4=23 & N_2O=296.

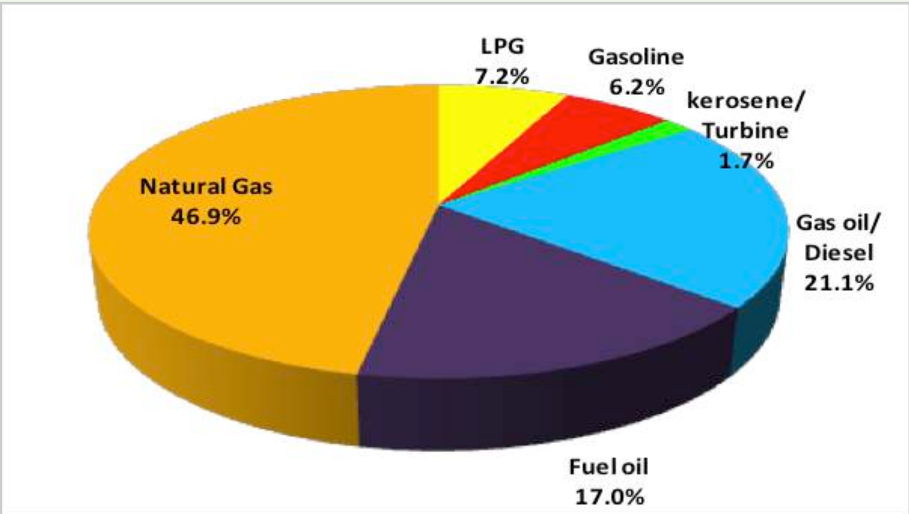


Figure (II.5):GHGs emissions from all energy consumption by fuel type in thousand tons/year, 2005/2006

Table (II.7) and figure (II.6) present GHG emissions by sector for different fuel types. As shown the electricity sector accounts for the highest percentage which is 37.2 % followed by the industry sector with 23.4% and the transportation sector by 22.5%.

Table (II.7): Sectoral GHG emissions in thousand tons/year, 2005/2006

Source Category / Sector	Consumption / GHGs Gases	Energy Consumption by Energy Type/ Products units and Relevant Emission Levels							Total Emissions CO_2e	Share (%)
		LPG	Gasoline	kerosene Turbine	Gas oil/ Diesel	Fuel oil	Total Petroleum	Natural Gas		
Industry	Consumption ('000 tons)	8372	0	3767	66349	140350	218838	319344	538182	
	CO_2 emissions	528.28	0	270.833	4916.461	10863.06	16578.632	17915.19	34493.83	
	CH_4 emissions	0.008	0	0.011	0.199	0.42	0.639	0.319	0.958	
	N_2O emissions	0.001	0	0	0.007	0.015	0.023	0	0.023	
	CO_2 e (Thousand tons)	528.7	0	271.2	4923.1	10877.1	16600.2	17922.5	34522.7	23.43%
Transport-ation	Consumption ('000 tons)	0	130774	20367	277350	17412	445903	10992	456895	
	CO_2 emissions	0	9062.6	1464.387	20551.635	1347.72	32426.353	616.651	33043.004	
	CH_4 emissions	0	0.393	0.061	0.832	0.052	1.338	0.011	1.349	
	N_2O emissions	0	0.014	0.002	0.029	0.002	0.047	0.018	0.065	
	CO_2 e (Thousand tons)	0	9075.7	1466.426	20579.45	1349.464	32471.073	622.207	33093.279	22.46%
Agriculture	Consumption ('000 tons)	0	0	920	33970	0	34890	0	34890	
	CO_2 emissions	0	0	66.134	2517.177	0	2583.311	0	2583.311	
	CH_4 emissions	0	0	0.003	0.102	0	0.105	0	0.105	
	N_2O emissions	0	0	0	0.004	0	0.004	0.001	0.004	
	CO_2 e (Thousand tons)	0	0	66.226	2520.584	0	2586.81	0.183	2586.992	1.76%
Res.& Comm.	Consumption ('000 tons)	159212	0	8804	18490	0	186506	22608	209114	
	CO_2 emissions	10046.3	0	632.993	1370.109	0	12049.367	1268.309	13317.676	

Source Category / Sector	Consumption / GHGs Gases	Energy Consumption by Energy Type/ Products units and Relevant Emission Levels							Total Emissions CO_2e	Share (%)
		LPG	Gasoline	kerosene Turbine	Gas oil/ Diesel	Fuel oil	Total Petroleum	Natural Gas		
	CH_4 emissions	0.158	0	0.026	0.055	0	0.24	0.023	0.263	
	N_2O emissions	0.017	0	0.001	0.002	0	0.02	0	0.02	
	CO_2 e (Thousand tons)	10054.885	0	633.874	1371.963	0	12060.723	1268.829	13329.551	9.05 %
Electricity	consumption('000 tons)	0	0	0	3913	160913	164826	749856	914682	
	CO_2 emissions	0	0	0	289.953	12454.68	12744.6	42066.9	54811.557	
	CH_4 emissions	0	0	0	0.012	0.482	0.494	0.75	1.244	
	N_2O emissions	0	0	0	0	0.017	0.017	0.001	0.019	
	CO_2e (Thousand tons)	0	0	0	290.3	12470.8	12761.1	42084.5	54845.6	37.23%
Petroleum	Consumption ('000(tons)	0	0	0	18705	5252	23957	127200	151157	
	CO_2 emissions	0	0	0	1386.041	406.505	1792.545	7135.9	8928.465	
	CH_4 emissions	0	0	0	0.056	0.016	0.072	0.127	0.199	
	N_2O emissions	0	0	0	0.002	0.001	0.003	0.042	0.045	
	CO_2 e (Thousand tons)	0	0	0	1387.9	407.0	1794.9	7151.3	8946.2	6.07 %
Total	Consumption ('000 tons)	167584	130774	33857	418777	323927	1074919	1230000	2304919	
	CO_2 emissions	10574.544	9062.6	2434.4	31031.4	25071.9	78174.843	69003	147177.843	
	CH_4 emissions	0.167	0.393	0.101	1.256	0.97	2.887	1.23	4.117	
	N_2O emissions	0.018	0.014	0.004	0.044	0.034	0.114	0.062	0.175	
	CO_2e (Thousand tons)	10583.618	9075.733	2437.735	31073.375	25104.415	78274.875	69049.603	147324.478	100.00%

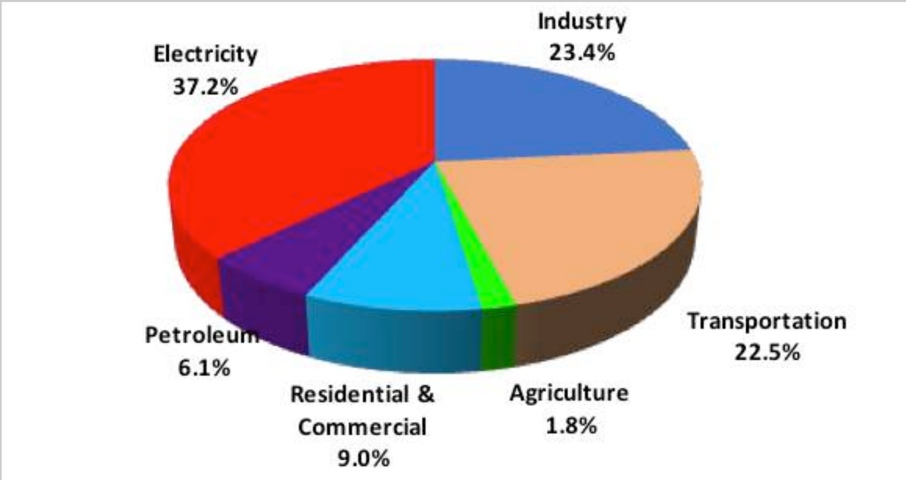


Figure (II.6): Sectoral GHGs emissions (CO2e), 2005/2006

Tables (II.8) and figures (II.7) to (II.10) show the trends in CO_2e, CO_2, CH_4 and N_2O emissions for All Energy consumption from 1991/1992 to 2005/2006.

Table (II.8): GHGs emissions trend for all energy consumption

Year	CO_2 Emissions (000'tons)	CH_4 Emissions (000'tons)	N_2O Emissions (000'tons)	CO_2 Equivalent (Million tons)	Evolution Ratio (%)
1991/1992	72346	2.5	0.47	72.54	
1992/1993	70807	2.4	0.44	70.99	-2.14
1993/1994	70216	2.3	0.41	70.39	-0.85
1994/1995	73515	2.4	0.43	73.70	4.7
1995/1996	79407	2.6	0.47	79.61	8.02
1996/1997	82050	2.7	0.48	82.25	3.32
1997/1998	90132	2.9	0.53	90.36	9.86
1998/1999	93756	3	0.55	93.99	4.02
1999/2000	98047	3.1	0.55	98.28	4.56
2000/2001	105151	3.3	0.56	105.39	7.23
2001/2002	108703	3.17	0.54	108.94	3.37
2002/2003	116927	3.36	0.57	117.17	7.55
2003/2004	120996	3.4	0.57	121.24	3.47
2004/2005	134065	3.9	0.66	134.35	10.81
2005/2006	147178	4.117	0.68	147.32	9.77

* CO_2e = CO_2 Equivalent according to the IPCC's third report, 2001.

* GWP (Global Warming Potential):CO_2 = 1& CH_4=23 & N_2O=296.

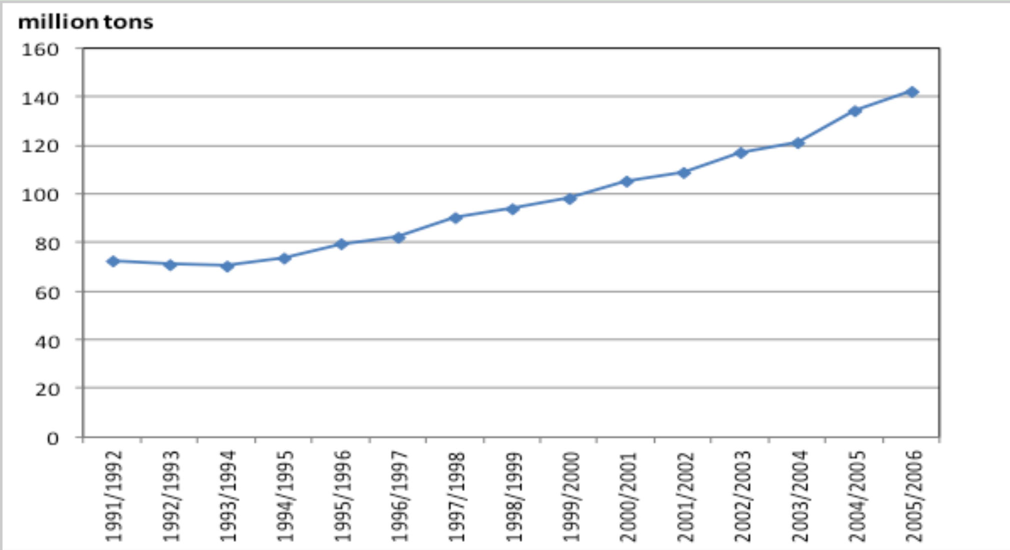


Figure (II.7) : Total CO2e emissions trend for all energy consumption (Average annual increase = 4.91%)

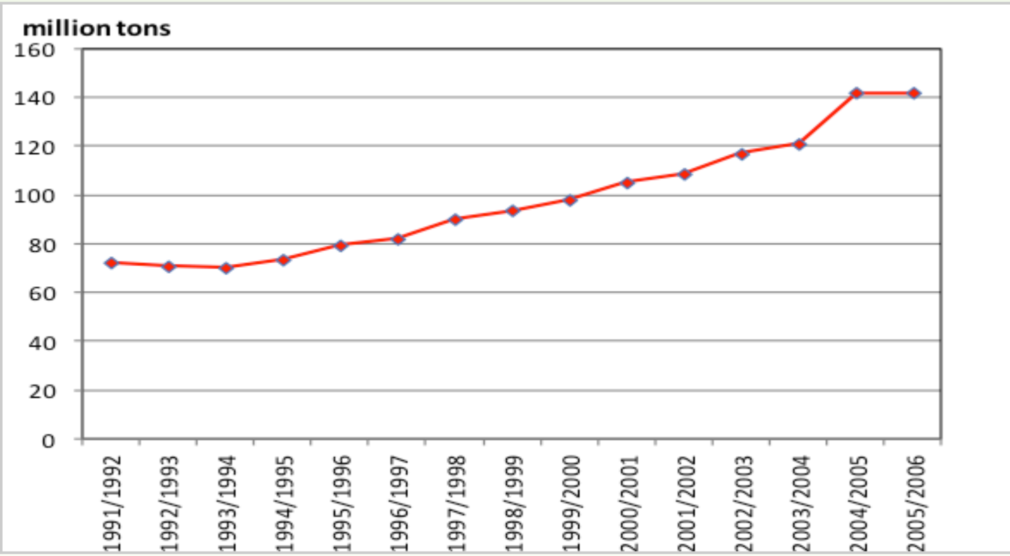


Figure (II.8): Total CO2emissions trend for all energy consumption (Average annual increase = 5.29%)

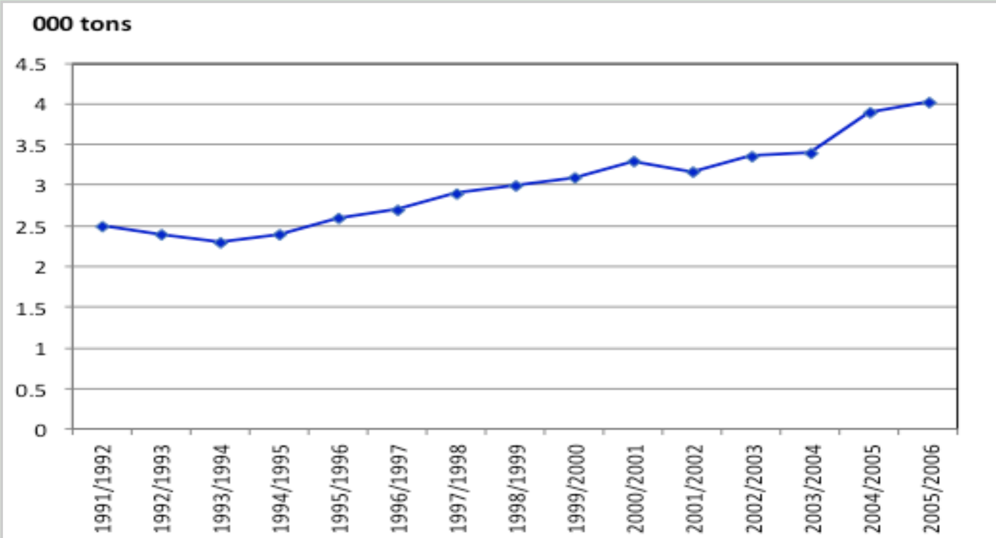


Figure (II.9): Total CH4 emissions trend for all energy consumption (Average annual increase = 3.49%)

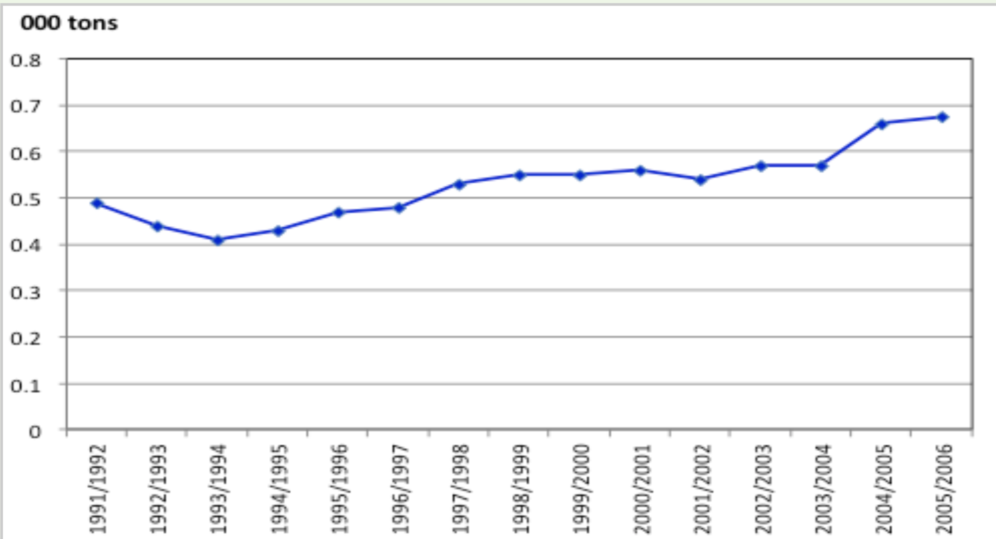


Figure (II.10): Total N2O emissions trend for all energy consumption (Average annual increase = 2.90%)

Considering the trends in GHG emissions resulting only from electricity generation from 1991/1992 to 2005/2006, these are presented in table (II.9) and figures (II.11) to (II.14).

Table (II.9): GHGs emissions trend for the period for electricity generation for 1991/1992 – 2005/2006

Year	CO_2 Emissions (10^3 kg)	CH_4 Emissions (10^3 kg)	N_2O Emissions (10^3 kg)	CO_2 Equivalent (10^3 kg)	Evolution Ratio (%)
1991/1992	24810800.0	14867.821	37507.640	24863175.461	
1992/1993	22943400.0	14316.350	29028.424	22986744.774	-7.52
1993/1994	21792700.0	14128.072	23784.192	21830612.264	-5.05
1994/1995	22898400.0	13539.456	24956.352	22936895.808	5.08
1995/1996	24498800.0	17050.153	28473.720	24544323.873	6.97
1996/1997	26085300.0	18761.238	30247.352	26134308.590	6.48
1997/1998	29595400.0	20643.972	39555.960	29655599.932	13.51
1998/1999	31614400.0	20081.645	42412.656	31676894.301	6.81
1999/2000	33514300.0	20634.841	37300.144	33572234.985	5.97
2000/2001	34939148.5	21507.990	31036.784	34991693.274	4.23
2001/2002	35897456.0	19234.663	27563.135	35944253.798	2.74
2002/2003	40572819.0	21815.824	30689.280	40625324.104	13.02
2003/2004	43157328.4	23946.379	30483.826	43211758.605	6.35
2004/2005	50061821.6	27259.798	49171.609	50138253.007	16.04
2005/2006	49070687.3	35791.938	41545.126	49148024.405	-1.98

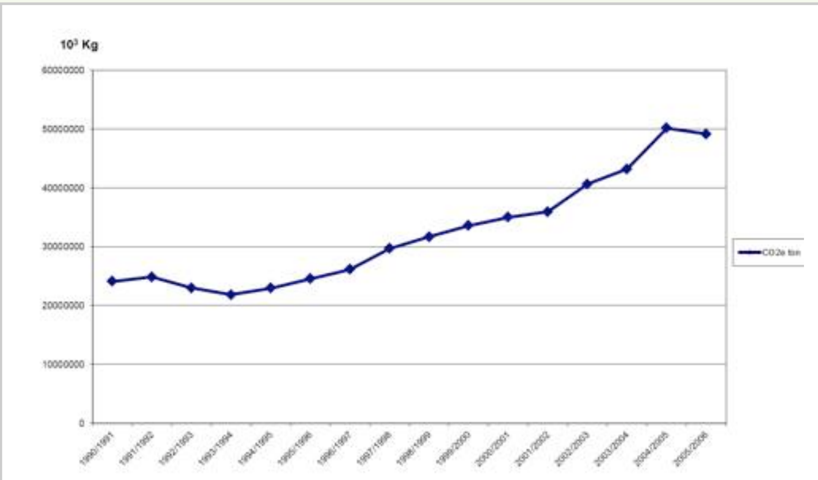
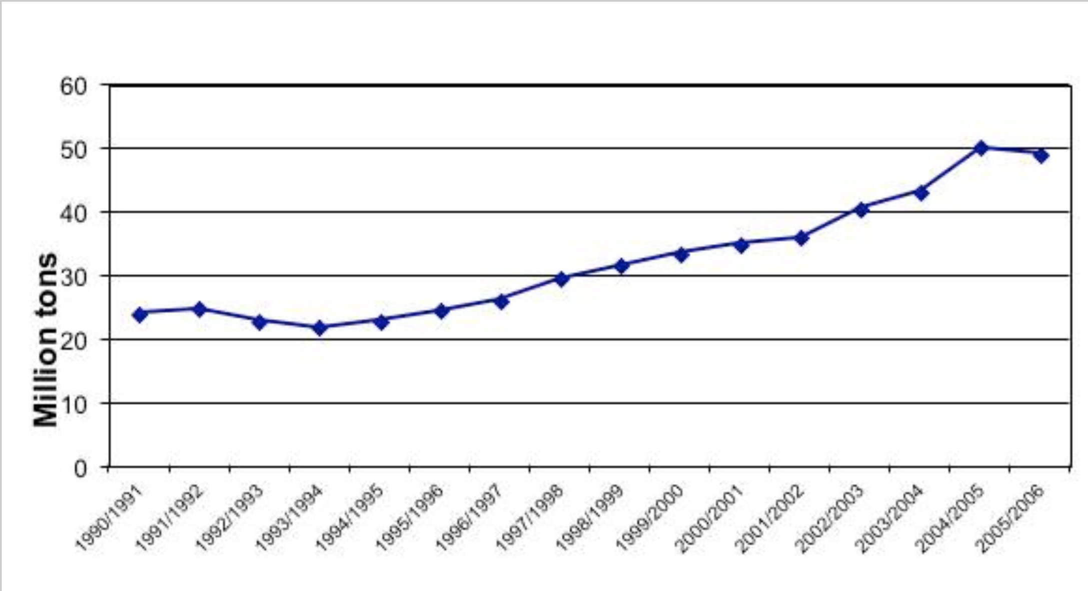


Figure (II.11) : Total CO_2e emissions trend for electricity generation (average annual increase = 4.84%)



Figure(II.12): Total CO2emissions trend for electricity generation (average annual increase = 5.36%)

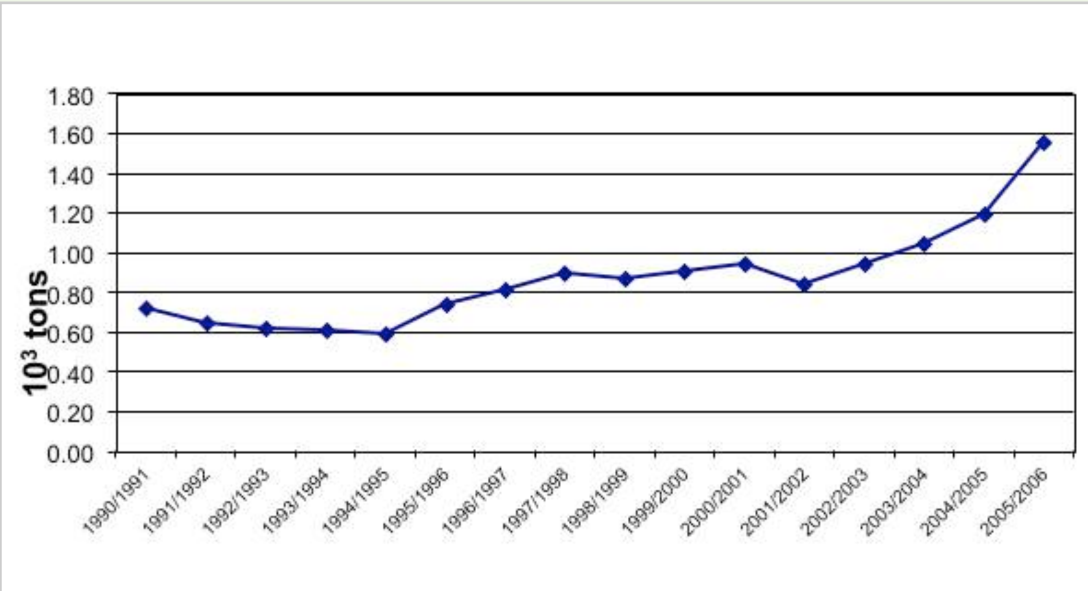


Figure (II.13): Total CH4emissions trend for electricity generation (average annual increase = 6.65%)

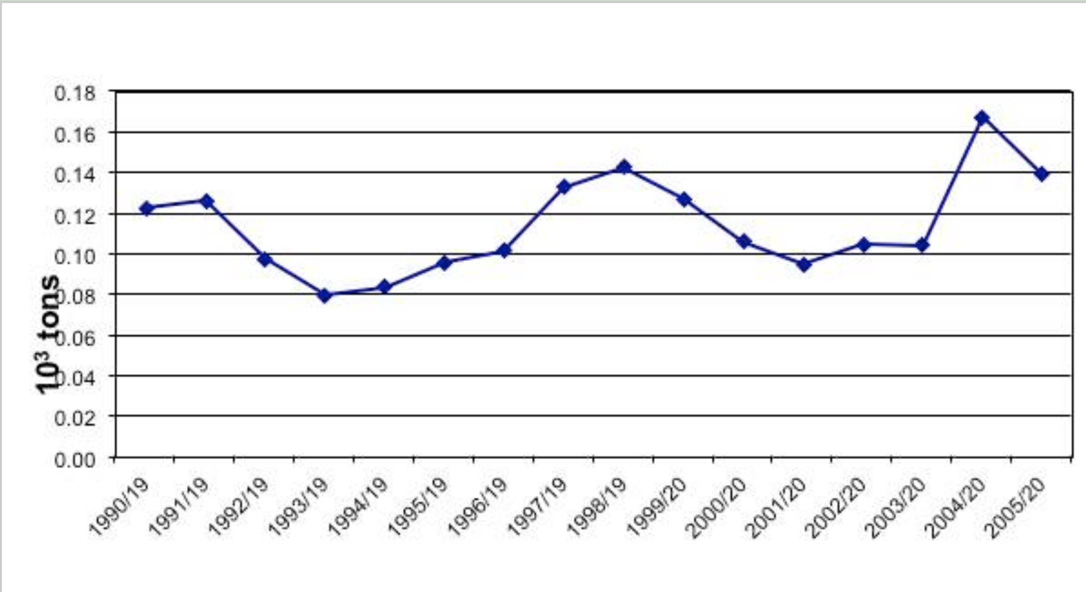


Figure (II.14): Total N2O emissions trend for electricity generation (average annual increase = 2.76%)

1.3.1.c. Fugitive Emissions

Fugitive GHG emissions from fuel combustion in All Energy Consumption are included in table (II.10).

Table (II.10):.Fugitive emissions from all energy consumption, 2005/2006

Products	Units	2005/2006
Emissions from oil production (fugitive, venting and flaring):		
Total CO_2 emission	000' ton CO_2	1,580.917
Total CH_4 emission	000' ton CH_4	382.224
Total N_2O emission	000' ton N_2O	0.022
Emissions from gas production and gas processing (fugitive, venting and flaring):		
Total CO_2 emission	000' ton CO_2	63.838
Total CH_4 emission	000' ton CH_4	0.040
Total N_2O emission	000' ton N_2O	0.001
Total GHGs Fugitive emissions from oil & gas	000' ton CO_2	1,644.756
	000' ton CH_4	382.264
	000' ton N_2O	0.023
Total CO_2e Fugitive emissions from oil & gas	000' ton CO_2e	1,644.756
	000' ton CO_2e	8,792.072
	000' ton CO_2e	1,927.552
Grand Total CO_2e	**000' ton CO_2e**	**12,364.38**
	Million ton CO_2e	**12.364**

II. 3.2. Transportation Sector

The transport sector is a major consumer of fossil fuels and therefore contributes a significant share of greenhouse gases (GHGs). The most common GHG emitted from the mobile sources in Egypt are carbon dioxide (CO_2). Its share ranges between 25-30% of total country GHG emissions. Other minor GHGs species such as nitrous oxide (N_2O) and methane (CH_4) are also emitted from transport. Moreover transport is the main source of important air pollutants, such as nitrogen oxides (NOx) carbon monoxide (CO), sulphur oxides (SOx), and non-methane hydrocarbons (NMHC). These pollutants can influence the concentration of the GHG through atmospheric chemistry.

II. 3.2.a. Methodological Approach and Data Sources

The IPCC Revised 1996 Guidelines and Good Practice Guidance references and standards are used for performing inventory estimate. For fleets sizes and composition, data are taken from the Ministry of Interior (MOI), the Egyptian National Railways (ENR) and the Ministry of Transport (MOT). Fuel consumption data sources are the Ministry of petroleum (MOP) and the Organization of Energy Planning (OEP). Other sources which assisted in filling data gaps included CAPMAS and the State Information Service (SIS).

There is deficiency in reliable local emission factors data and hence the present calculations relied mainly on data from reliable international sources that takes into account variation in local operating conditions. Suitable data were taken from the following sources:

1. IPCC Revised 1996 Guidelines and Good Practice Guidance
2. Joint EMEP/CORINAIR Atmospheric Emission Inventory Guidebook, Third Edition. Copenhagen: European Environment Agency, 2001
3. EDGAR v.2 Data Base, 1995
4. The EDGAR 3.2 Fast Track 2000 dataset (32FT2000)

II. 3.2.b. Road Transport

The road fleet in Egypt consists of various types of vehicles such as cars, taxis, buses and minibuses, trucks, motorcycles, tractors and special purpose vehicles. The number of vehicles registered in Egypt is continuously increasing at a rate much higher the rate of increase of the roads and this causes a sever traffic problems and increased fuel consumption and consequently increased GHG emissions. In recent years (after 2005)the total number of vehicles began to increase at a very high rate (11.8% annual increase rate in the period 2005/2010 compared to 2.2% in the period 2000/2005). This results from high increase rate of private cars and motorcycles. The annual increase rate of private cars jumped from 6.1% in the period 2000/2005 to 12.6% in the period 2005/2010 while the rate of increase of motor cycles jumped from 3.8% to 24.1% for the same periods.

Increase of the number of private cars reduces traffic speeds and increases specific fuel consumption. Low price of Chinese motorcycles and facilitation in terms of payment encouraged workers, technicians and students to buy them instead of using the crowded public transport. Moreover, bicycles which are considered an important non-motorized means of transport with nearly zero GHG emissions were also replaced.

The overall fleet composition is continuously changing. The percentage of private cars increase from 44.5% in 2000 to 49.1% in 2010 while that of motor cycles increased from 16 to 24.3% in the same period. The percentages of the other types of vehicles such as buses and trucks remain constant or slightly decrease. Despite the large number of motor cycles, it has little effect on overall fuel consumption because of their small engines and shorter distances travelled. The main fuel consuming road vehicles are private cars, taxis, trucks and buses. The numbers of buses are increasing at a very small rate. This increase is due to increase in private, tour, tourism and school buses while public buses increase at very small rate (3.5% compared to 12.6%, 11.8%, and 12.1% for travel, tourism and school buses).

Road vehicles capacity and age are important indicators of fuel consumption and emissions. Capacity of cars is represented by engine displacement, for trucks by pay load and for buses by number of passengers. Vehicle age is represented by model year or km travelled. So the road fleet has been further analyzed according to age and capacity. Data from traffic departments for major governorates as well as published sales rates have been used in this analysis. In 2005 higher percentages of taxis, buses and truck are more than 15 years old. However, most of the old private cars and taxis are low efficiency Fait vehicles. The percentage of old private cars is being gradually reduced because of the high purchase rate of more efficient modern vehicles. For taxis, the scrapping rate is very low because of the traffic regulations that restricted registration of new taxis in greater Cairo area but now a scrapping program is applied and supported by the Ministry of Environment to replace old taxis with by-fuel (gasoline and natural gas) new vehicle. In the first phase about 35000 taxis have been replaced. It should be noted here that the number of taxis includes shared taxis which are minibuses of 8 passengers operated by individuals and private sector. These represent problem as a considerable percentage of them are old, poorly maintained and of high fuel consumption. Their number is expected to increase to fill the gap between growing passenger trip demand and limited public transport supply.

II. 3.2.c Rail Transport

Egypt was the first country in the region to use a railway transport system. The Egyptian railway system witnessed a slow rate of growth of the route but the track length increased sharply in the nineties due to using double track in Cairo Aswan line. The number of working locomotives increased in the period 1990-2000 and started to decrease again and this may be due to lack of maintenance and availability of spare parts replacement funds. The number of working freight wagons shows similar trends but the number of passenger coaches slightly increased. A study made by the World Bank and Egyptian government for restructuring Egyptian's railways showed that the motive power and rolling stock fleet is aging. In locomotives, only 146 are less than 20 years old. Availability of locomotive is below standard (about 70–73 percent against a target of 85 percent). Similarly, part of the passenger coach fleet has reached the end of its economic life while freight wagons are older. Some rolling stock maintenance facilities are old and lack adequate equipment. Only 180–200 kilometers of track is renewed annually, an amount that might be insufficient on a heavily used network. The rail transport comes directly after road in passenger transport but its importance as a means of freight transport is diminishing.

II. 3.2.c. Water Transport

The water transport in Egypt is an important sector as it constitutes a large number of vessels working between large number of ports either on sea shores or on river banks. Table 11 shows the number of both sea ports and river ports in Egypt as well as the total berths length and land and water areas of commercial ports. The sea port handled a large number of different ships of different types and different nationalities. The number of vessels registered in the Egyptian ports in 2006 is about 19416 with 13306vessels registered in the territorial waters and 6110 registered in the international waters. These vessels vary in capacity.

This activity involves development of international trade volume through Egyptian ports as well as the share of the national sea commercial fleet. The increasing activity volume in Egyptian ports has an impact on Egypt 'share in the international marine bunker fuel market. Egyptian ports achieved positive growth to the volume of cargo throughput during 2006-2010. In 2010 Egyptian ports handled about 135.4 million tons compared to 106.6 million tons in 2006 representing a growth rate up to 27%: As for containers handling Egyptian ports, it achieved positive growth rates as related to the number of TEUs handled in 2006- 2010. In 2010 Egyptian ports handled about 6.7 million TEUs compared to 4.6 million TEUs in 2006 recording a growth rate up to 46.6%.

II. 3.2.d. Civil Aviation Fleet

The Egyptian civil aviation fleet belongs mostly to the national public company, Egypt Air. Egypt Air fleet in 2005 consisted of 38 planes of different seating capacities in addition to three cargo planes. The company offers more than 400 flights a week to more than 60 international and national destinations. Also, there are 9 private companies with a total of 19 different types of planes. Egypt Air was responsible in 2004 for 19 per cent of total international schedule and non-scheduled passenger traffic through Cairo and the main Egyptian international airports, and for approximately 61 per cent of total domestic (scheduled and non-scheduled) passenger traffic. Egypt Air fleet can be considered as medium age fleet.

However, the composition of Egypt Air fleet is continuously changing in number and type of planes. In 2003, the number increased to 62 with an average age of 9.5 years. The fleet composition also changed where the number of Boeing 737 increased from 6 in 2005 to 24 in 2014 used mostly in domestic flights while the number of Boeing 777 increased from 5 to 9 in the same period and they are mostly used in international flights. The number of air ports increased from 15 airports in 1995 to 70 in 2005 paved air ports in addition to a number of 17 non-paved and heliports. There are nine airports of these through which most air traffic takes place.

Although Egypt has more than 70 airports with paved runways almost all passengers are carried through 20 airports. Eight of these deal with about 95% of the total traffic while the remaining airports deal with about 5% of the total traffic, see However, because most aircraft landing in small airports are small aircrafts, the corresponding number of flights to small airports represents about 10% of the total number of flights.

II. 3.2.e. Fuel Consumption and GHG Emissions from Transport Sector

Transport sector consumes different types of fuels such as gasoline, jet fuel, gasoil, heavy fuel oil and natural gas in addition to other types of petroleum products such as lubrication oils etc. Data from the Organization of Energy Planning (OEP) and the Egyptian General Petroleum Corporation (EGPC) shows fuel consumption is continuously increasing as shown in table (II.11)and figure(II.15). During the period 1990/2000 the average annual rate of increase of the fuel consumption of the transport sector was 4.4% and dropped to 3.1% in the period 2000/2004 but started to increase again to reach 7.2 in 2004/2006. This could be attributed to the increase in gasoline affected by increase in the number of cars motor cycles and three-wheelers. Figure II.16 shows the development of transport sector of different types of fuel and it is clear the gas oil/diesel fuel and gas oil represent the large share in the total transport fuel.

Table (II.11): Development of fuel consumption in transport sector, thousands tons

Year	Fuel Consumption Thousand tons						
	Gas oil/ Diesel Fuel	Gasoline	Jet Kerosene	Natural Gas	Residual Fuel Oil	Total Fuel (toe)	Lubricant
1990	2896	2139	452	0	153	6085.34	79
1997	3731	2024	416	0	705	7346.75	246
1998	4074	2155	408	0	847	7986.22	268
1999	4917	2205	418	0	738	8844.92	297
2000	5375	2200	457	80	646	9369.44	311
2001	5454	2226	420	100	787	9601.43	319
2002	5664	2266	403	150	800	9919.13	327
2003	5769	2348	422	189	820	10204.91	465
2004	5874	2516	451	198	846	10568.91	347
2005	6139	2739	456	208	1278	11533.81	380
2006	6403	3043	422	228	1287	12144.59	400

Source: OEP and EGPC

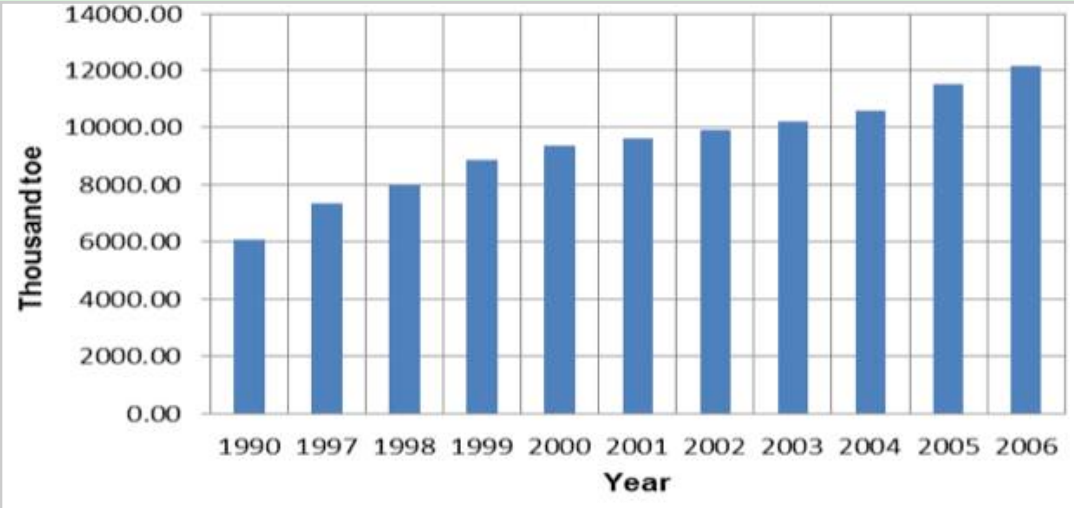


Figure (II.15): Development of transport fuel consumption in toe

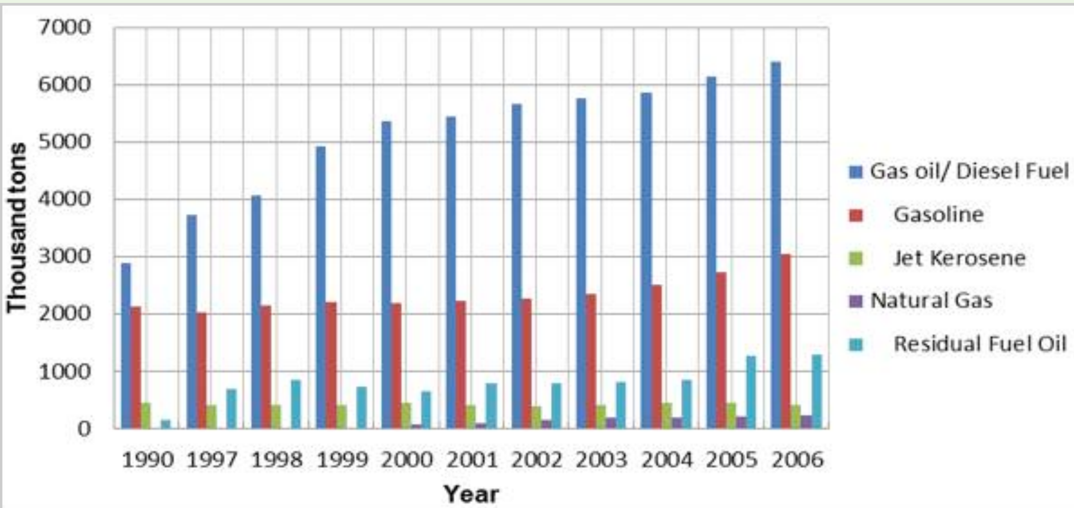


Figure (II.16): Development of transport consumption of different types of fuels

The distribution of fuel consumption among different transport modes shows that Road transport consumes the largest share of total fuel in this sector as shown in table (II.12). It should be mentioned here that this fuel consumption includes fuel consumed by national ships and planes engaged in international trips. This will be taken into consideration in the present calculations. It should be noted also that non-road transport consumes a considerable amount of fuel.

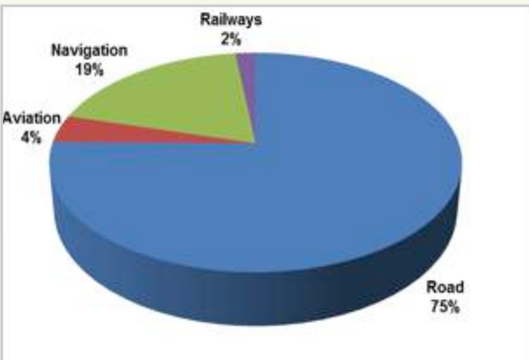
Table (II.12): Fuel consumption in transport sector (thousand tons), 2005/2006

Fuel type	Road Transport	Railways	Aviation	Navigation	Agricultural Tractors and Machinery (1)	Non-road
Gasoline	2740					
Gasoil/diesel	5125.7	193		819.7	889	2240
Kerosene		4.6	422			
Heavy fuel oil				1278		
Other products(2)	323	20		20	28	12

(1) Includes construction and other non-road machinery

(2) Include lubricating oils, greases and asphalts

Source: The Egyptian General Petroleum Corporation



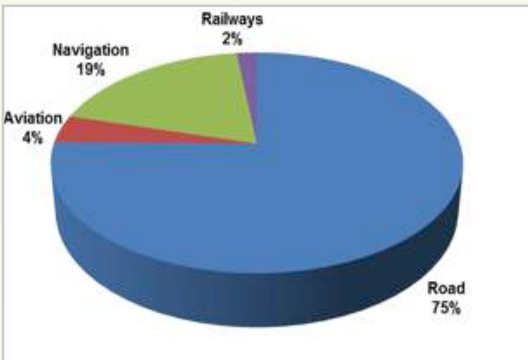


Figure (II.17): Fuel consumption of different transport modes in 2005;(a) without tractors and non-road, (b) with tractors and non- road.

The calculated CO_2 emissions using reference approach method for transport and bunker fuels is shown in figure (II.18). It follows the same trends of total fuel consumption discussed above. Table (II.13) shows the annual GHG emissions from the transport sector from 2000 to 2006.

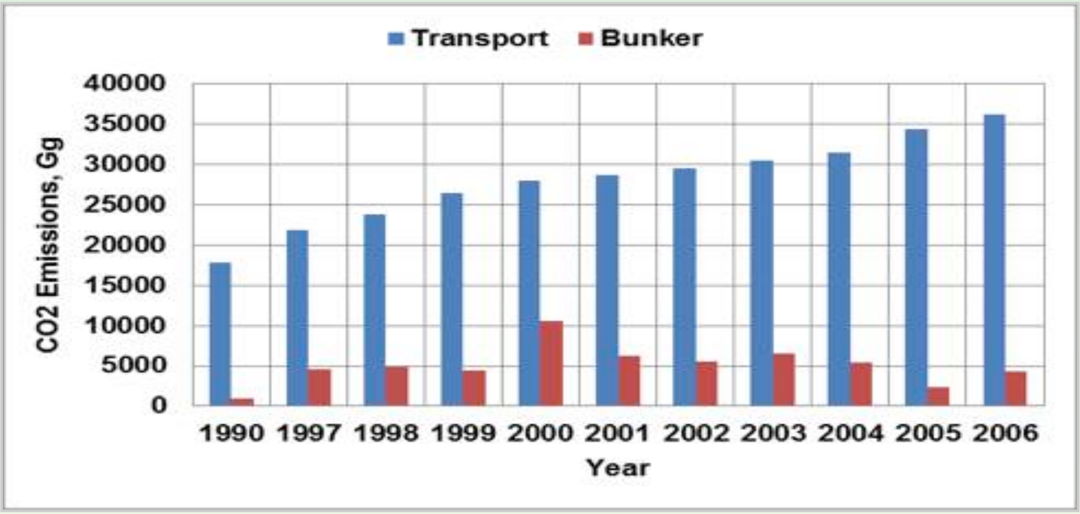


Figure (II.18) Development of CO2 emissions from transport and bunker fuel combustion using reference approach

Table (II.13): Annual GHG emissions from transport sector, Gg

Year	CO_2	CH_4	N_2O
2000	26532.14	3.455	0.229
2001	27086.57	3.571	0.232
2002	28037.98	3.771	0.239
2003	28826.13	3.962	0.245
2004	29880.89	4.162	0.254
2005	32335.24	4.5296	0.278
2006	34216.4	4.906	0.290

The emissions of non CO_2 GHG from transport have negligible value even if the equivalent CO_2 greenhouse effect for CH_4(21) and N_2O(310) are considered. The contribution for both gases is less than 0.3%.

Considering the transport mode, the calculations shows that road transport is the main emitter of GHG as shown in Figure (II.19).

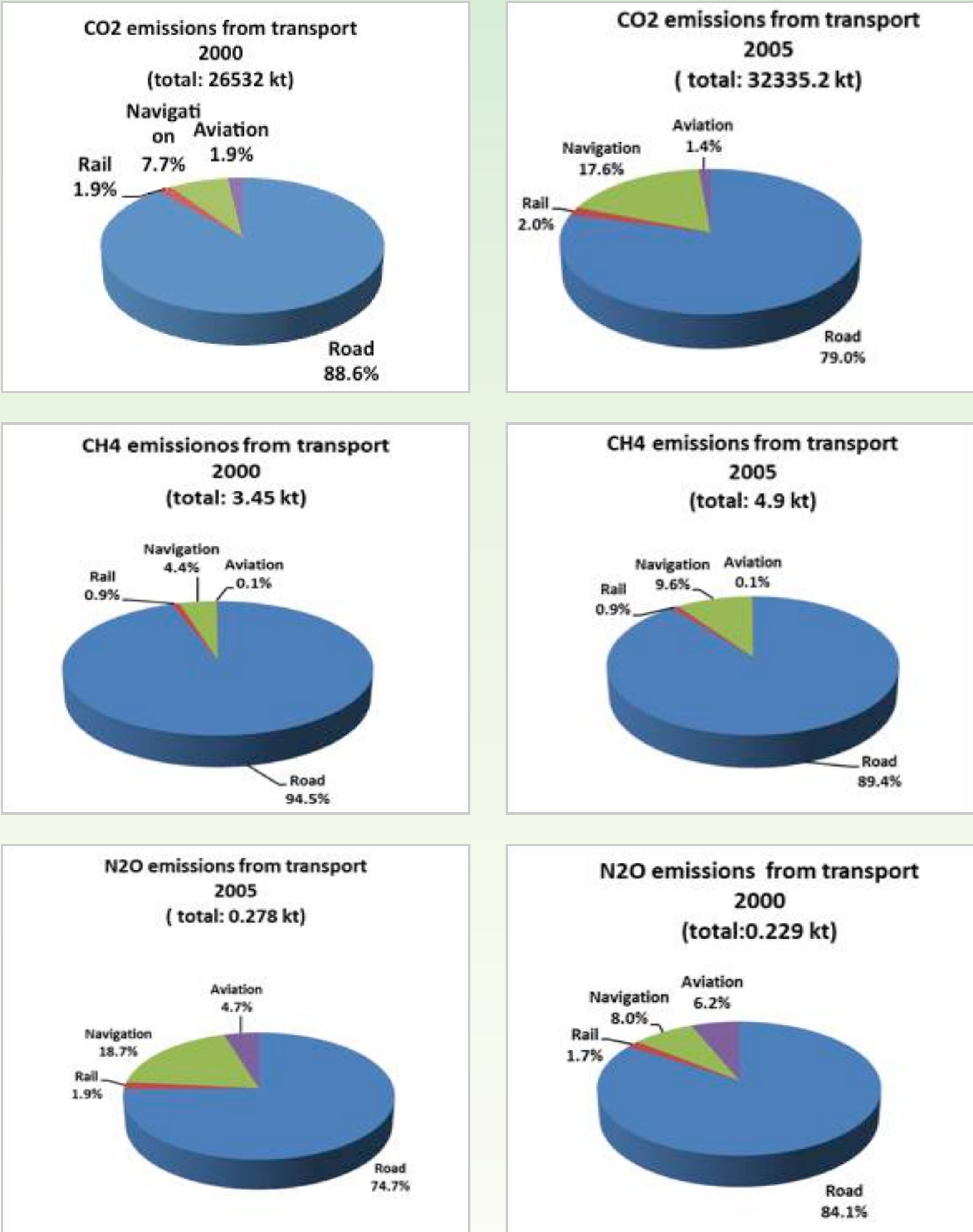


Figure (II.19): GHG emissions from different modes of transport in years 2000 & 2005

The transport sector is responsible for large portion of gaseous pollutants emissions such as nitrogen oxides (NOx), carbon monoxide (CO) non methane organic compounds (NMOC) and sulphur dioxide (SO_2) as shown in table (II.14) and figure (II.20).

Table (II.14): Pollutants emissions from transport sector, Gg

Year	CO	NOx	NMOC	SO_2
2000	1049.48	294.32	199.97	86.72
2001	1068.40	313.51	203.52	99.30
2002	1093.27	325.14	208.15	101.79
2003	1128.97	330.47	214.78	103.71
2004	1194.65	338.00	227.16	106.26
2005	1304.01	399.42	248.00	146.45
2006	1424.74	414.72	270.68	147.54

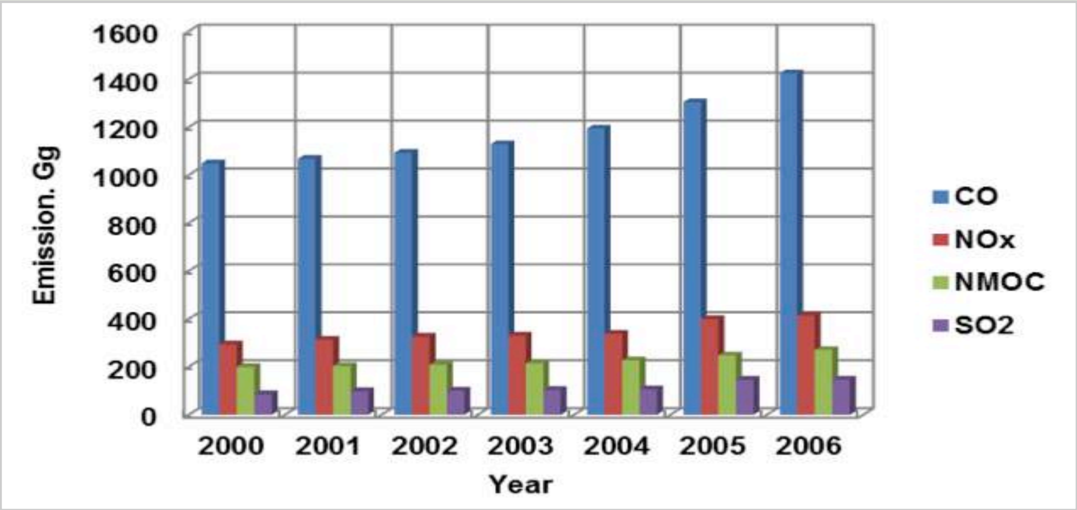
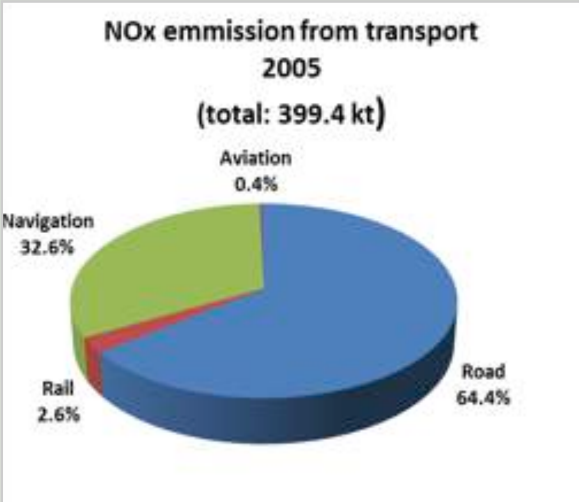
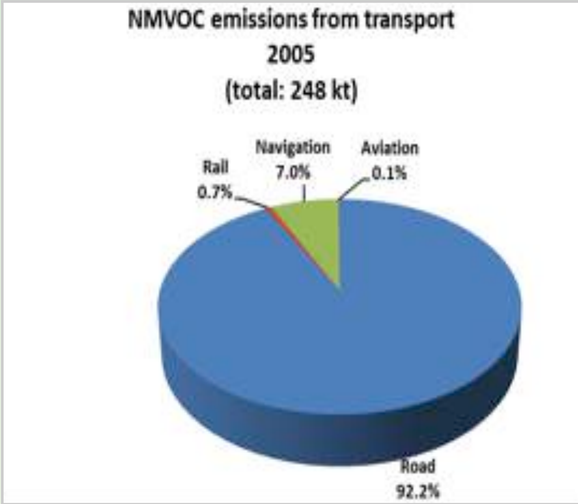


Figure (II.20): Development of pollutants emissions from transport sector

Considering different transport modes road transport emits most CO and NMOC and large portion of NOx. Navigation emits considerable amount of NOx (15-30%) depending its share in total fuel consumption that vary from one year to another.





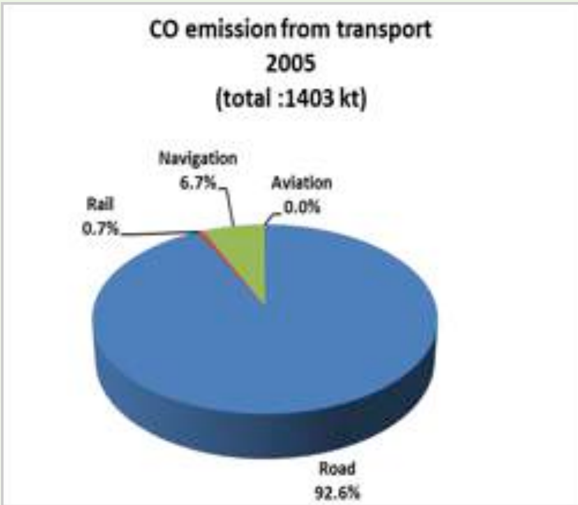


Figure (II.21): Emission of gaseous pollutants from different transport modes in 2005

SO_2 emissions depend totally on the sulphur content of fuel. Natural gas and light petroleum products such as gasoline and kerosene have low sulphur content while heavy fuel such as residual fuels have high sulphur content.As a result navigation that uses heavy fuel is responsible of most SO_2 emissions, see Figure (II.22).

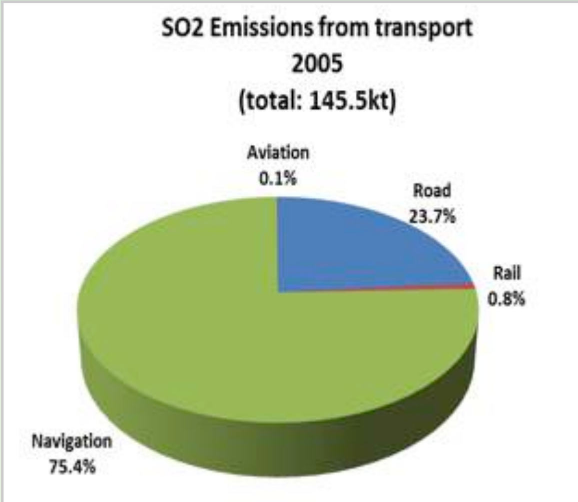
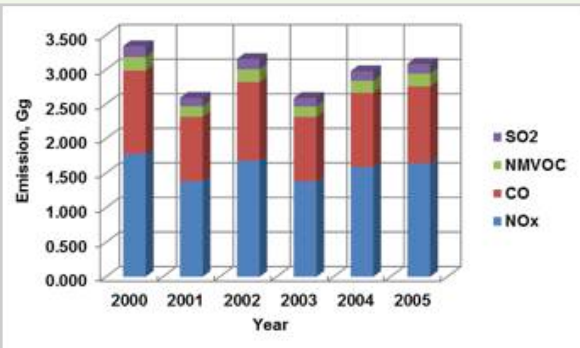


Figure (II.22): SO2 emissions from different modes in 2005

For aviation, figure (II.23) show that GHG emissions of aviation transport is mostly CO_2 with negligible amount of CH_4 and N_2O. The result show no general trend as this type of transport is very sensitive to global economic crises and also local stability of the country, especially for countries where aviation transport is used mainly by tourists.

(A) **(B)**



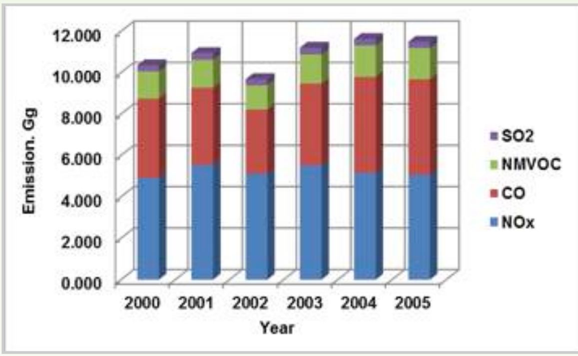


Figure (II.23): Development of pollutants emissions from aviation transport (2000-2005)
(a) Domestic Aviation and (b) International Aviation

The air pollutants emitted by aviation transport are mainly carbon monoxide and nitrogen oxides with small amounts of non-methane hydrocarbons and sulphur oxides. Emissions are mainly during take-off where the engine works at full power and at higher fuel to air ratio.

II. 3. 3. The Industry Sector

Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC Guidelines) is the main source of methodology for the present work. The 1996 IPCC Guidelines and the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (GPG2000) are also considered. Good practice guidance is provided for major emissions source categories – including: Cement production, lime production, iron and steel industry, adipic acid and nitric acid production, aluminum production, magnesium production, sulfur hexafluoride (SF6) emissions from electrical equipment, and from other sources, per fluorocarbons (PFC), hydro fluorocarbons (HFC) and SF6 emissions from semiconductor manufacturing, emissions of substitutes for ozone depleting substances (ODS substitutes) including seven sub-source categories, and HCFC-22 manufacture.

The "2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3, Industrial Processes, and Product Use" will be considered. The improvements are depicted in the Annex 3: Improvements since 1996 of the 2006 IPCC, which will be highly considered.

All the IPCC Guidelines for GHG inventory emitted from the Industrial processes require data related to production, technology and raw materials introduced into the process. According to the available quality of data processed, accuracy and uncertainty, they are divided into Tier1, Tier2 and Tier3. Tier 1 methodologies employ IPCC default GHG Emission Factors. Higher Tier methods as Tier 2 and Tier 3 are considered whenever the required information is available.

II. 3. 3. a. Methodological Approach and Data Sources

The "Industrial Development Authority (IDA)" was depended onto for supplying the factory license data including the production capacity, raw material and date of license issuance. The "Ozone Layer Protection Unit/EEAA" is the main information source for the concerned ODS substitutes in Egypt. Moreover, by analyzing data obtained from the "Industrial Development Authority (IDA)" and the "Ozone Layer Protection Unit/EEAA", data gaps were identified leading to the next step.

The actual data sources are the Holding Companies and the Companies working in the targeted industries. But, to get correct information for the GHG inventory, specific awareness about the required specific information need to be developed. This was accomplished through two steps:

First, well design of log sheets for the specific companies containing specific questionnaire.

Second, by identification of data gaps, actual visits were held for specified companies for specific jobs to fulfill the gaps.

According to the "1996 IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories", Chapter 3, "Industrial Processes", the Main sources of GHG emissions in the industrial processes are:

- Cement industry
- Limestone and Dolomite production and use
- Iron and steel industry

- Nitrous Oxide (N2O) production for nitric acid and fertilizers production
- Carbon Fluorides from Aluminum smelting
- Sulfur Fluorides due to Magnesium production
- Emissions Related to Consumption of Halocarbons (HFCs , PFCs) and Sulfur Hexafluoride (SF 6) as alternative of Ozone depletion materials

II. 3. 2. b. Industrial GHG Emissions by Gas Type and Sources

Tables (II.15) to (II.18) depict the emissions by gas, while the concerned industry is considered.

Table (II.15): Emissions of carbon dioxide (CO2) from Industry, 2005

Item	Industrial Source	Carbon Dioxide, tons/year	CO_2 Equivalent, tons/ year
1	Cement production	16,716,754	16,716,754
2	Lime production	202,844	202,844
3	Iron and steel industry	1,576,175	1,576,175
4	Ammonia not used in Urea	1,924,848	1,924,848
Total CO_2 from Industry		**20,420,621**	**20,420,621**

Table (II.16): Emissions of nitrous oxide (N2O) from Industry, 2005

Item	Industrial Source	Nitrous Oxide, tons/ year	CO_2 Equivalent, tons/year
1	Nitric acid production	16,266	5,042,460
Total N_2O emissions from Industry =		16,266	
Total CO_2 equivalent =			**5,042,460**

Table (II.17): PFC's Emissions from aluminum production, 2005

Item	Industrial Source	Type of Emissions	Emissions, ton/year	100 years GWP	CO_2e, tons
1	Aluminum production	CF_4	145	6500	942,500
		C_2F_6	15	9200	138,000
Total CO_2 equivalent emissions in tons/year					**1,080,500**

Table (II.18):Emissions due to Ozone Depleting Substances (ODS Substitutes) not including refrigeration and air conditioning applications, 2005

Type of Emission	Emissions, ton/year	100 years GWP	CO_2 Equivalent, tons/year
Halons, (almost Halon-1301)	22.31	7140.0	159293.4
Halon-1211			
Halon-1301			
Halon-2402			
Carbon tetrachloride CTC	5	1400.0	7,000
Methyl chloroform	150.00	146.0	21,900
Methyl bromide	314.00	5.0	1,570
CFC's Chloroflourocarbons (almost R12)	821.20	10900	8,951,080
HCFC's Hydrochloroflourocarbons (almost R22)	3470.00	1810	6,280,700
Total, tons =	4783		
Total CO_2e, tons =			**15,421,543**

Table (II.19):Emissions due to Ozone Depleting Substances (ODS Substitutes) for Refrigeration and Air Conditioning applications, 2005

Item	Species	Chemical Formula	Imported amount, ton/year	GWP	CO_2 Equivalent, tons/year
1	R-23	HFC-23	0.145	11,700	1,697
2	R-32	HFC-32	4.02	650	2,613
3	R-134a	HFC-143a	0.572	3,800	2,174
4	R-407	Blend of R 32, R125 and R 134a	3.39	1,526	5,171
5	R-408	Blend of R22 and R125, R 134a	0.817	794	649
6	R-410	Blend of R32, R125	18.935	2,050	38,817
Total CO_2 Equivalent Emissions, tons/year =					**51,120**

As for the total amount of GHG emissions from all surveyed industrial sectors emissions in 2005, they are shown in table (II.20). They are also presented by gas type and sector in tables (II.21) and (II.22) respectively and figures (II.24) and (II.25).

Table (II.20): GHG emissions from surveyed industrial sectors emissions, 2005

Sector, (GHG Gas)	CO_2 Equivalent, thousand tons/year
Cement, (CO_2)	16,717
Ozone Depleting Susbstances, (ODS Substitutes, HFC's & PFC's)	15,473
Nitric Acid Production, (N_2O)	5,042
Ammonia not used in Urea, (CO_2)	1,925
Iron and steel, (CO_2)	1,576
Aluminum Production, (PFC's)	1,077
Lime, (CO_2)	203
Semi-Conductors Production, (SF_6)	0.00
Magnesium Production, (SF_6)	0.00
CH_4, No reported Industry	0.00
TotalCO_2 Equivalent, thousand tons/year	**42,013**

Table (II.21): GHG emissions by gas due to industrial processes in Egypt, 2005

GHG Gas type	CO_2 Equivalent, thousand tons/year
CO_2, (Cement, Ammonia not used in Urea, Iron and steel, Lime)	20,421
ODS Substitutes, HFC's & PFC's, (Ozone Depleting Susbstances)	15,473
N_2O, (Nitric Acid Production)	5,042
PFC's, (Aluminum Production)	1,077
SF_6, (Semi-Conductors Production, Magnesium Production)	0
CH_4, No reported Industry	0
Total CO_2 Equivalent, thousand tons/year	**42,013**

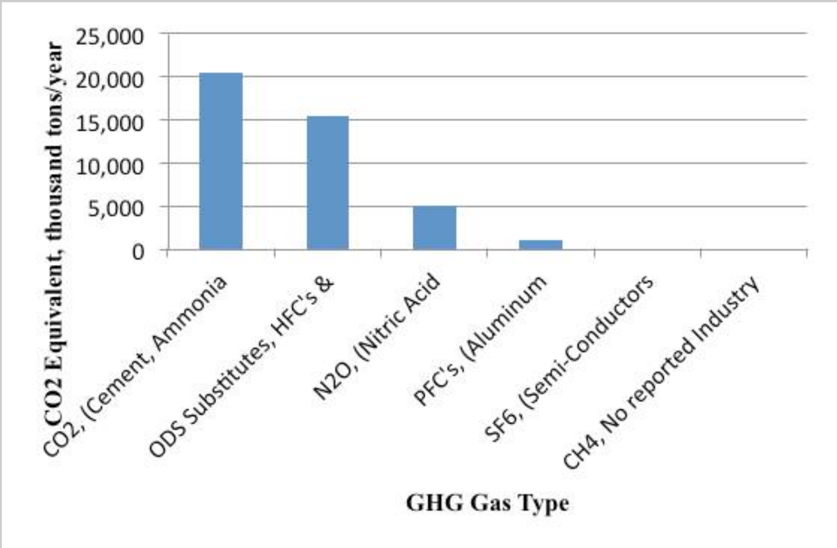


Figure (II.24): GHG emissions by gas from industrial sector, 2005

Table (II.22): GHG emissions by sector in descending order of industrial sectors emissions, 2005

Sector	CO_2 Equivalent, thousand tons/year
Cement (CO_2)	16,717
Ozone Depleting Susbstances (ODS Substitutes, HFC's & PFC's)	15,473
Nitric Acid Production (N_2O)	5,042
Ammonia not used in Urea (CO_2)	1,925
Iron and steel (CO_2)	1,576
Aluminum Production (PFC's)	1,077
Lime (CO_2)	203
Semi-Conductors Production (SF_6)	0
Magnesium Production (SF_6)	0
CH_4, No reported Industry	0
Total CO_2 Equivalent, thousand tons/year	**42,013**

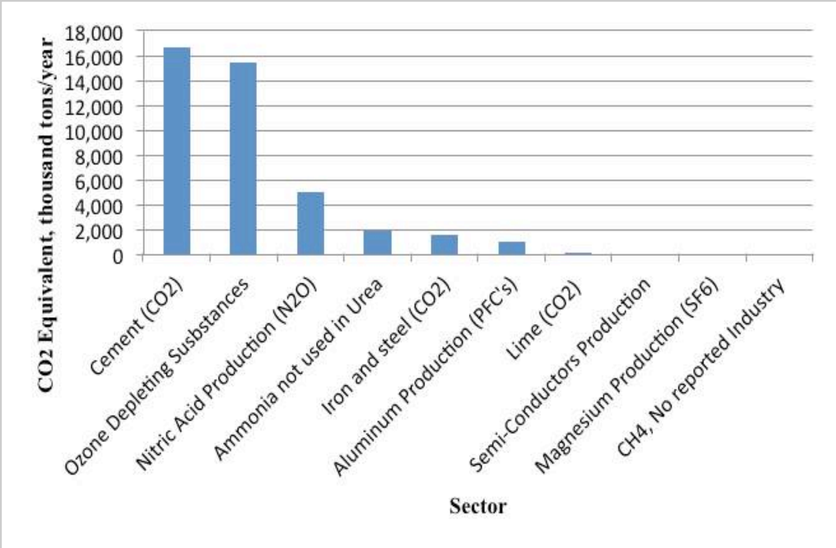


Figure (II.25): GHG emissions by sector in descending order of industrial sectors emissions, 2005

II.3.4. Agriculture Sector

In Egypt, agricultural activities contribute directly to the emissions of greenhouse gases through various processes. The following sources have been identified to make a more complete breakdown in the emission calculation:

1. Enteric fermentation of livestock;
2. Manure management;
3. Rice cultivation;
4. Agricultural soils; and
5. Field burning of agricultural residue.

The processes and activities of the agriculture are the main sources of CH_4 and N_2O. However, the field burning of agricultural residues is the source of CH_4, N_2O, CO and NO_X. There are no ecosystems in Egypt that could be considered as natural savannas; consequently, no greenhouse gas emissions exist for this subcategory. In the last submissions of Egypt of Initial National Communication (INC 1999), and Second National Communication (SNC 2010) the most important GHG in the agriculture sector was methane (CH_4) followed by nitrous oxide (N_2O) in the INC. However, in the SNC, the most important GHG was nitrous oxide (N_2O). For the current submission (Third National Communication, TNC) the base year is 2005 and the period of 1999-2012 is the estimated period of the GHG emission from agriculture sector.

II.3.4.a Methodological Approach and Data Sources

The default methodology of IPCC revised guidelines of 1996 and IPCC good practice guidance of year 2000 has been used to calculate the methane emission from ***enteric fermentation***. Tier 1 (simplified method) has been used as well as default EF specific for the animal type, the climate zone (warm), geographic region (Africa and Middle East) and the degree of the region development (Developing Countries). Tier 2 method was not applied because accurate activity data was not available.

IPCC methodology of IPCC revised guidelines of 1996 and IPCC good practice guidance 2000 has been used to calculate the CH_4 and N_2O emissions from ***manure management***. Default EFs specific for the animal type, the climate zone (warm), geographic region (Middle East) and the degree of the region development (Developing Countries) were applied to estimate CH_4 emissions. As well as default IPCC values of nitrogen excretion per head of animal (Nex_T) [kg/animal/yr] for near east & Mediterranean, and IPCC default N_2O EFs from animal waste management systems (AWMS) were applied to estimate N_2O emissions. Percentages of AWMS in Egypt were estimated according to experts' judgment, for dairy and non-dairy cattle, buffalos, sheep, and goats groups. According to experts, solid storage and drylot, pasture range and paddock (grazing), burning as fuel were the main manure management systems applied under Egyptian conditions. Solid storage and drylot system represent 67% of total manure management systems of cattle and buffalo categories. N_2O from solid storage and drylot was reported under manure management, whereas, pasture range and paddock and manure used for fuel were excluded from manure management calculations. Pasture range and paddock were reported under direct soil emissions of N_2O from animal production, and the used manure for fuel was reported in Energy section (IPCC, 1996).

Default methodology of IPCC revised guidelines of 1996 and IPCC good practice guidance of 2000 has been used to calculate the CH_4 emissions from ***rice cultivation***. According to the available data that published in Sass et al, 1993 the climatic conditions of rice cultivated area in Egypt is more or less similar to the presented in Texas. In addition to both soils are clayey in texture. Therefore, default IPCC average EF specific for USA (Texas) of fully irrigated rice and continuously flooded rice (25 g CH_4/ m^2 season) was applied to estimate CH_4 emissions. Regarding to cultivation period, IPCC EF was calculated to monthly values to estimate the EF of the early cultivars.

As for ***agricultural soil*** and based on the IPCC methodology, three sources of N_2O emissions are distinguished in GHGs inventory. They entail direct emissions of N_2O from agricultural soils, direct emissions of N_2O from animal production, and indirect emissions of N_2O from agricultural activities. Direct emissions of N_2O from agricultural soils include total amounts of nitrogen added to soils through cropping practices such as the application of synthetic fertilizer, nitrogen from animal waste, production of nitrogen–fixing crops, and nitrogen from crop residue mineralization. Total nitrogen excretion from manure management was used to calculate manure nitrogen used as fertilizer. Calculation of N_2O emissions from soil nitrogen mineralization due to cultivation of histosols (soil with very high organic matter and having special emission factors) is not considered here, as it does not exist in Egypt. Estimates of N_2O emissions from animals were based on animal waste deposited directly on soils by animals in pasture, range and paddock. Calculations of indirect N_2O emissions from agricultural soil are based on the volatilization and subsequent atmospheric deposition of NH_3 and NOx originating from the application of fertilizers and animal manure, as well as leaching and runoff of the nitrogen that is applied to or deposited on soils.

Default methodology of IPCC revised guidelines of 1996 has been used to calculate emissions from ***field residuals burning***. Country specific crops data on ratios of residue to crop production, fraction of residue burned, dry matter content of residue and carbon and nitrogen contents of residue were used.

II.3.4.b Total GHG Emission for Agriculture Sector

Figure (II.26) presents the total emissions (in CO_2 equivalent) of the five sources of GHGs in agriculture sector. Agricultural soil is the main source of GHGs emissions from agriculture sector by contribution of 50.75% in 2005 and 49.36% for average period of 1999-2012. However, in the last submission (SNC) it was 32.24% of total agricultural emissions. Manure management was the second important source by contribution of 10% in 2005 and 19.46 for the average period of 1999-2012 which are lower than the SNC which was 28.99%. This was followed by enteric fermentation by a contribution of 22.8% in 2005 and 19.89%, for the average period of 1999-2012, as compared to the SNC which was 25.48%. Then, rice cultivation by contribution of 11.73% in 2005 and 9.46%, for the average period of 1999-2012. However, in the last submission (SNC) it was 7.82%. Then finally, the field burning of agricultural residue contributed by 4.43% in 2005 and 3.49 for the average period of 1999-2012 as compare to 5.47%. The same results are illustrated in Table (II.23) for year 2005 and Table (II.24) for the average period of 1999-2012.

In the current submission of year 2005, the most important GHG in the agriculture sector is nitrous oxide (N_2O) contributing by 65.32% of the sector expressed in CO_2 equivalent, followed by CH_4. However, in last submission of the SNC it was accounting to 75.4 %, of the sector, that is because of increasing consumption amount of N fertilizers. Total GHG emissions from the Sector in 2005 amounted to 39,446.39 Gg CO_2 equivalent.

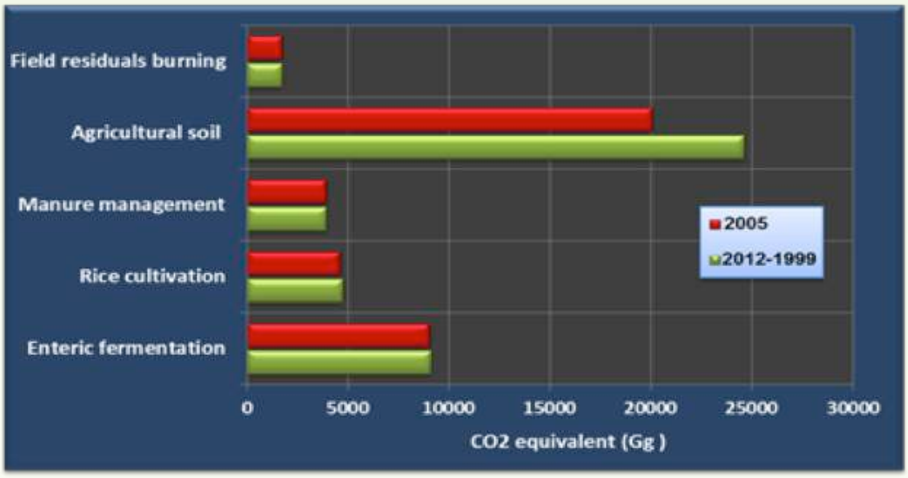


Figure (II.26): Total GHGs emissions of the five key sources of GHGs in agricultural sector for the average period of 1999-2012 and year 2005

Table (II.23): Total GHGs emissions from agricultural sector in Egypt, 2005

GHG source and sink categories	CO_2	CH_4	N_2O	Total
	CO_2 equivalent (Gg)			
Total Agriculture	-	15,797.99	23,648.4	39,446.39
Enteric Fermentation	-	9,063.29	-	9,063.29
Manure Management	-	639.72	3333.75	3,973.48
Rice Cultivation	-	4,636.55	-	4,636.55
Agricultural Soils	-	NE	20,021.96	20,021.96
Field Burning of Agricultural Residues	-	1,458.43	292.69	1,751.12

Table (II.24): Total GHGs emissions from agricultural sector in Egypt for the average periods of 1999-2012

GHG source and sink categories	CO_2	CH_4	N_2O	Total
	CO_2 equivalent (Gg)			
Agriculture	-	15,850.1	34,003.9	49,854.00
Enteric Fermentation	-	9,088.74	-	9,088.74
Manure Management	-	615.55	3,304.91	3,792.047
Rice Cultivation	-	4,714.84	-	4,714.84
Agricultural Soils	-	NE	24,608.66	24,608.66
Agricultural Residues	-	1,458.43	308.52	1,739.51

II.3.4.c GHG Emissions from Enteric Fermentation

Methane is a direct product of animal metabolism generated during the digestion process. The greatest producers of methane are ruminants (cattle, buffalo and sheep). The amount of the produced and excreted methane depends on the animal digestive system and the amount and type of the animal feed. The estimations in this inventory include only emissions in farm animals.

Thirteen years average livestock population data for all livestock types were obtained from agricultural statistics of livestock reports of Economic Affairs Sector, Ministry of Agriculture and Land Reclamation, Egypt (MALR, 1999- 2012).

Figure (II.27) presents the average distribution population trend of livestock categories in Egypt from year 1999 to year 2012. Cattle population is categorized to dairy cattle group and non-dairy cattle group.

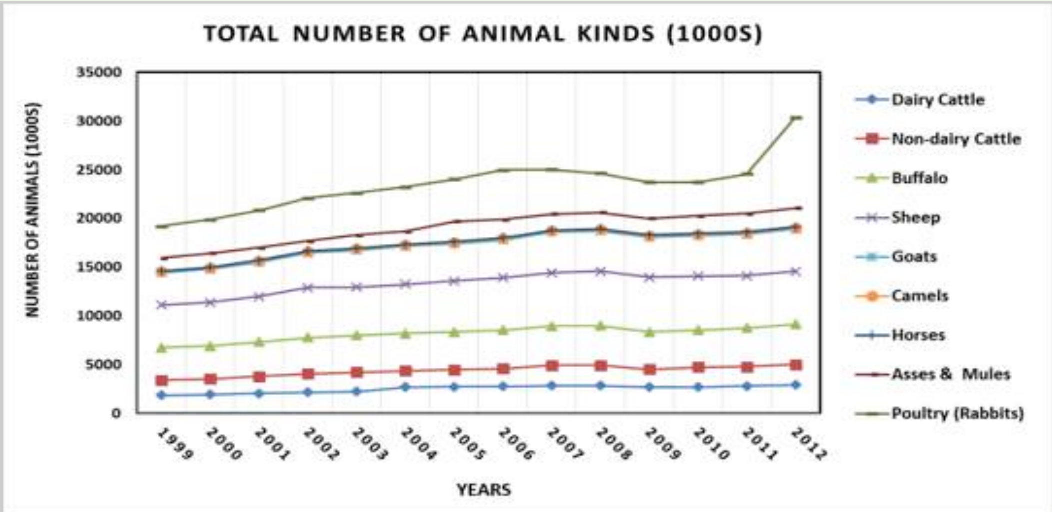


Figure (II.27): Livestock categories population from year 1999 to year 2012

Total emissions of methane from enteric fermentation revealed an increase from 323.4 Gg in year 1990 to 384.8 Gg in year 2000 (15.95 % increase), while it increased to be 394 Gg for year 2005 (22 % increase than 1990). This increase is mainly attributed to the increase in livestock population. Buffalo group was the key source of CH_4 emission from enteric fermentation, by total emission of 213.68 Gg, accounting 48% whereas cattle group was the second key source by total emission of 154.44 Gg. While for average period of 1999-2012, Buffalo group was 209.40 Gg, and for cattle group it is 150.53 Gg. Figure (II.28) illustrates total CH_4 emissions from livestock due to enteric fermentation the period of 1999-2012. Meanwhile, Figure (II.29) shows the total CH_4 emissions from livestock categories due to enteric fermentation for 2005 year.

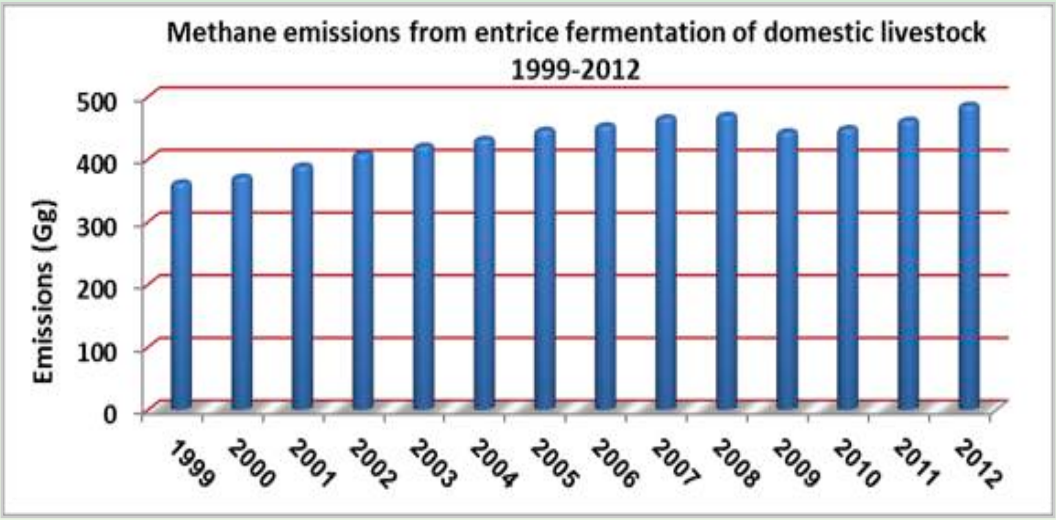


Figure (II.28): Trend in CH4 emissions (Gg) from enteric fermentation, 1999-2012

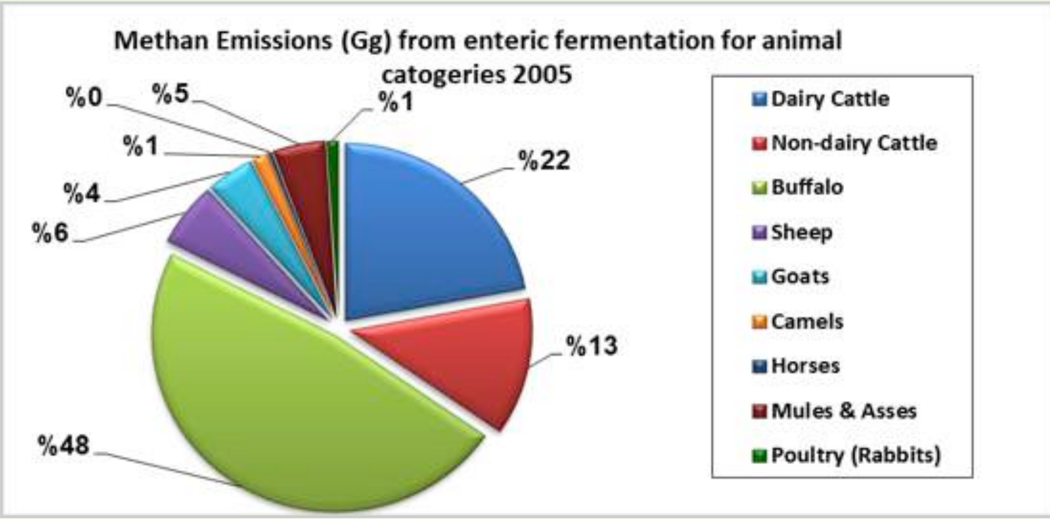


Figure (II.29): Total CH4 emissions (Gg) from livestock categories due to enteric fermentation

II.3.4.d Manure Management

The management of livestock manure produces both methane (CH4) and nitrous oxide (N2O) emissions. In 1999 Egyptian submission, CH4 emissions from manure management were estimated, whereas N2O emissions from the same source were not included. In 2010 submission and the current submission (TNC), both CH4 and N2O emissions from manure management are estimated.

The livestock population data were identical to the data used in estimating emissions from enteric fermentation. Livestock categories of camels, horses, swine, and mules and asses are not included in N2O estimation, because the required accurate activity data was not available.

Total CH4 emissions from manure management increased from 23.23 Gg in 1990 to 27.78 Gg in 2000 submission, by increment percentage of 16.38%, while it increased to be 30.46 Gg for year 2005 (23.74 % increase than 1990). This increase is mainly contributing to the increase in livestock population. Buffalo group was the key source of CH4 emission from manure management, by total emission of 19.43 Gg. While for average period of 1999-2012, buffalo group was 19.03 Gg, and for cattle group it is 7.22 Gg in 2005 and 6.91 Gg for average period of 1999-2012. Figure (II.30) illustrates total CH4 emissions from livestock due to manure management the period of 1999-2012. Figure (II.31) shows the total CH4 emissions from livestock categories due to manure management for 2005 year.

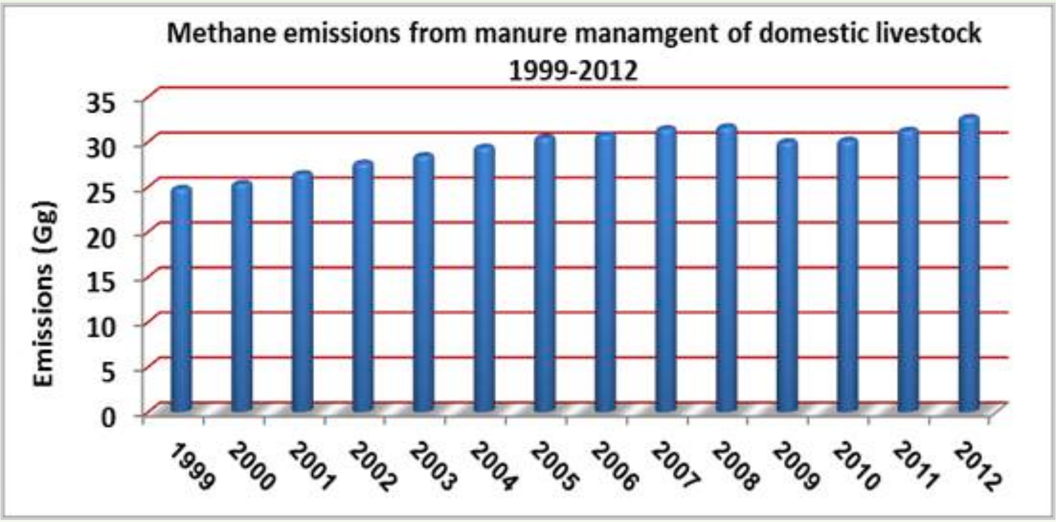


Figure (II.30): Trend in CH4 emissions from domestic livestock 1999-2012

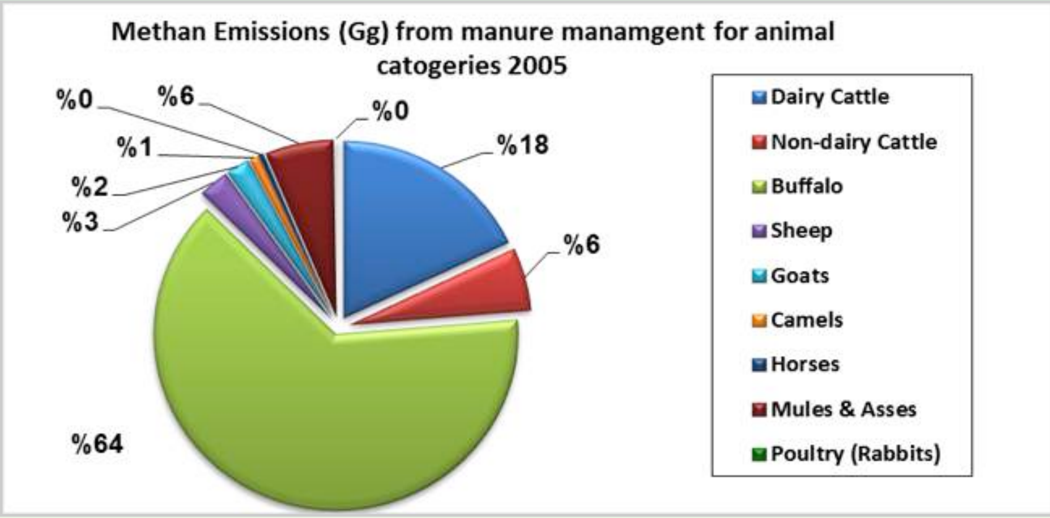


Figure (II.31): Total CH4 emissions from livestock categories due to manure management

II.3.4.d Rice cultivation

Anaerobic decomposition of organic material in flooded rice fields produces methane, which escapes to the atmosphere primarily by transport through the rice plants (IPCC, 1996). However, not all of the methane that is produced is released into the atmosphere. As much as 60 to 80 per cent of the methane produced is oxidized by aerobic methanotrophic bacteria in the soils (Holzapfel-Pschorn et al., 1985; Sass et al., 1990). Some of the methane is also leached to ground water as dissolved methane, and some methane also escapes from the soil via diffusion and bubbling through the floodwaters. The amount emitted CH4 from rice field is influenced according to rice cultivars, growing season length, soil type, air and soil temperature, irrigation management, fertilization program, farm management practices, and drainage practices (IPCC, 1996).

Thirteen years average of rice cultivated area data were obtained from FAOSTAT l © FAO Statistics Division 2014 l. Figure (II.32) shows the change in rice cultivated area from year 1999 to year 2012. In Egypt all rice fields are irrigated by continuous flooding. Moreover, two main types of rice cultivars are cultivated now under Egyptian conditions. The first type is conventional cultivars that stay in field for 3 months. Whereas, early cultivars is the second type that stay in field for 2 months. Switching cultivars was strongly taken place in rice cultivation since 1995.

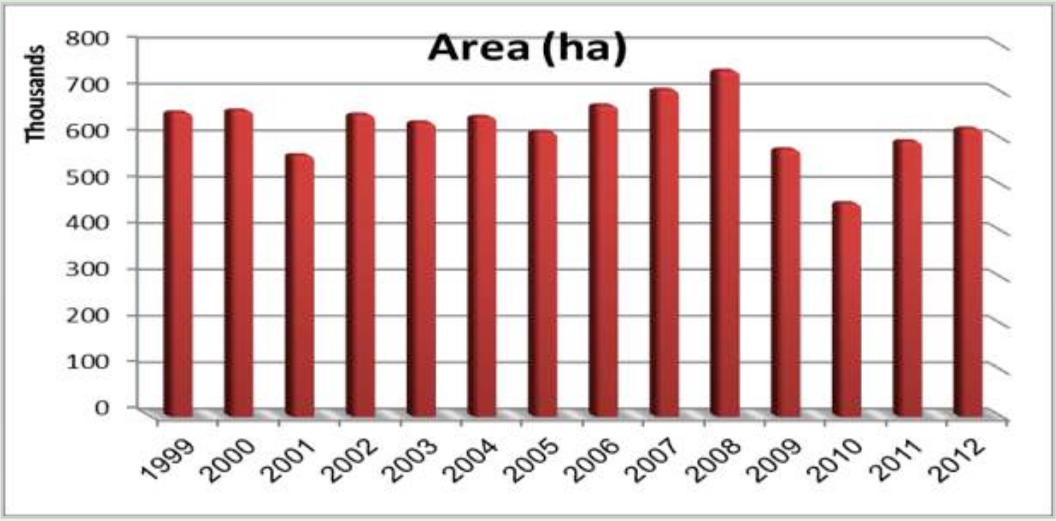


Figure (II.32): Rice cultivated area from year 1999 to year 2012. (FAOSTAT 2014)

Total CH4 emission from rice cultivation is decreased from 235.87 Gg in 1999 to 220.78 Gg in 2005 submission, by a reduction of 6.4%. Meanwhile, it steady decreased to be 223.30 Gg for year 2012 (5.2 % decrease than 1999).This reduction is mainly attributed to the rapid switching of long duration traditional cultivars to early-maturing short-duration cultivars. The conventional cultivars stay about four months under flooding, while the early maturing ones stay only about three months under flooding. Also, because decrease cultivation area of rice during last decade in Egypt.

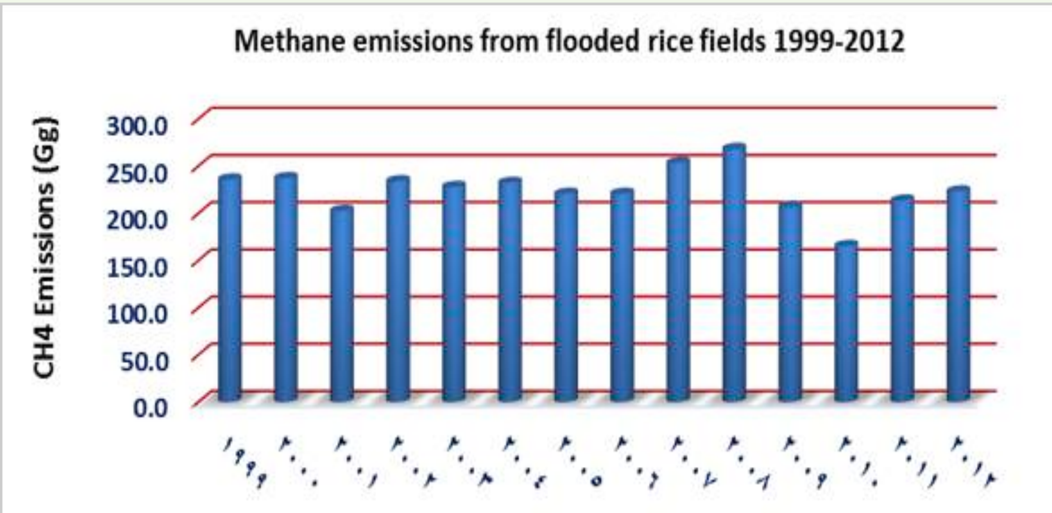


Figure (II.33): Total CH4 emissions from flooded paddy rice

II.3.4.e Agriculture Soil

A number of agricultural activities add nitrogen to soils, thereby increasing the amount of nitrogen available for nitrification and denitrification, and ultimately the amount of N2O emitted. Three sources of N2O emissions are distinguished in methodology:

- Direct emissions of N2O from agricultural soils
- Direct soil emissions of N2O from animal production
- Indirect emissions of N2O conditioned by agricultural activities

Direct emissions N2O from agricultural soils include total amount of nitrogen to soils through cropping practices. These practices include application of synthetic fertilizer, nitrogen from animal waste, production of nitrogen – fixing crops, nitrogen from crop residue mineralization and soil nitrogen mineralization due to cultivation of histosols.

Calculations of indirect N2O emissions from nitrogen used in agriculture are based on two pathways. These are: volatilization and subsequent atmospheric deposition of NH3 and NOx (originating from the application of fertilizers and animal manure), and leaching and runoff of the N that is applied to, or deposited on soils. These two indirect emission pathways are treated separately, although the activity data of synthetic fertilizer and manure applied to soil used are identical.

Total emissions of N2O from agricultural soil revealed an increase from 21.1 Gg in year 1990 to 32.98 Gg in year 2000 (36.03 % increase). While it increased to be 64.59 Gg for year 2005 (196 % increase than 1990). Figures (II.34) and (II.35) show N2O emissions from animal waste management for year periods and animal categories. The average period of 1999-2012, the total emissions of N2O from agricultural soil is 79.38 Gg (Figure II.36). Total N2O direct emissions from agricultural soil were estimated by 31.20 Gg in 2005 submission. The N2O emissions from synthetic fertilizers presented about 87.9% of the total N2O direct emissions from agricultural soil which is attributed to huge amount of N consumption in crop cultivation in Egypt during last few years as shown in table II.25.

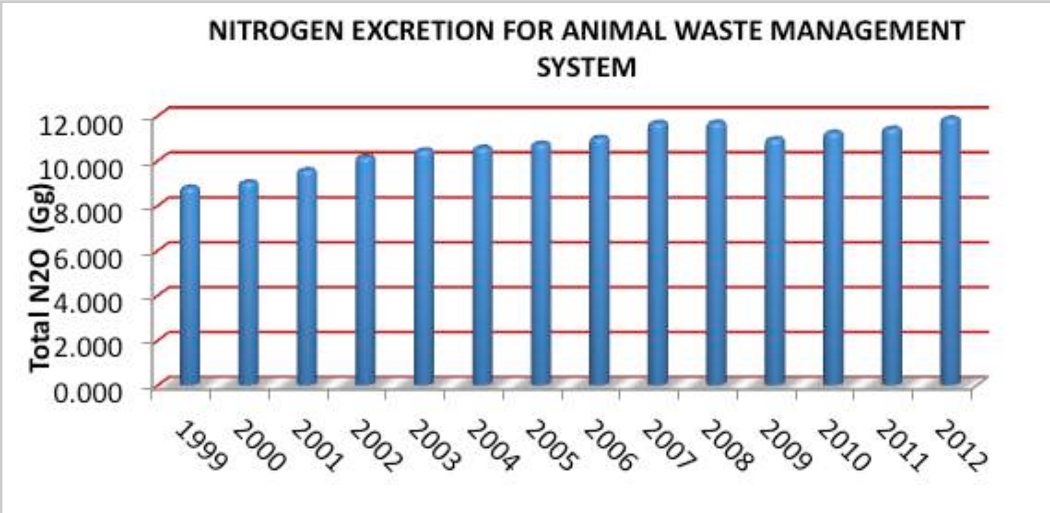


Figure (II.34): Total N_2O emissions from animal waste management for 1999-2012

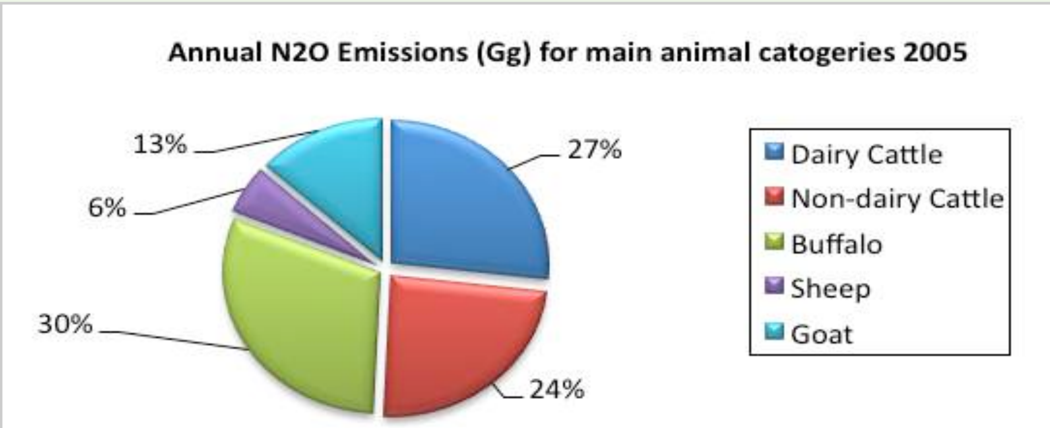


Figure (II.35): N_2O emissions from animal waste management categories, 2005

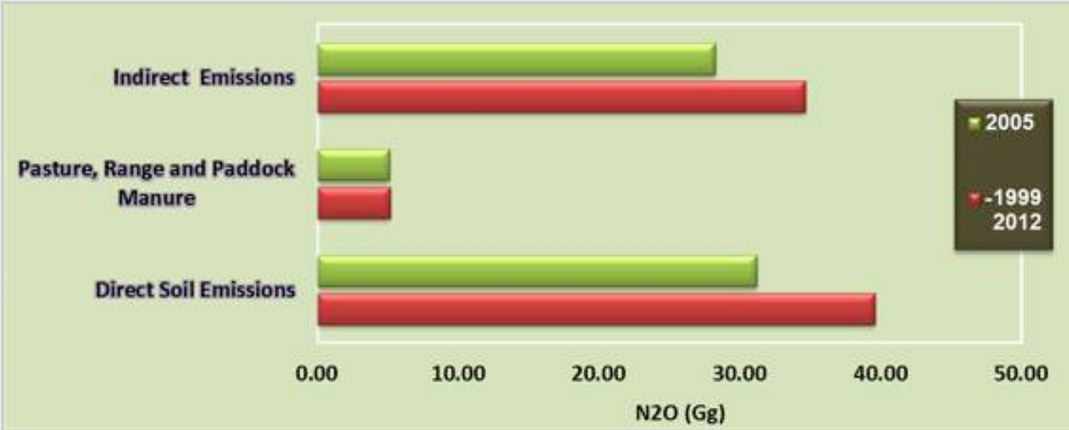


Figure (II.36): Indirect, direct and paddock manure N_2O emissions for the periods of 2005 and average of 1999-2012

Table (II.25): Total N_2O emissions from agricultural soil in year 2005

Type of N input to Soil		Direct Soil Emissions of N_2O (Gg)
Direct N_2O emissions from agricultural soil (Gg)	Synthetic fertilizer	27.44
	Animal waste	3.66
	N-fixing crops	0.06
	Crop residue	0.04
	Total	31.19
N_2O emissions from grazing animals (Gg)	Total	5.12
Indirect N_2O emissions from agricultural soils (Gg)	Total	28.27
Total N_2O emissions from agricultural soil		**64.59**

II.3.4.f Field Residuals burning

Large quantities of agricultural wastes are produced, from farming systems in the form of crop residue. Burning of crop residues is not thought to be a net source of carbon dioxide (CO_2) because the carbon released to the atmosphere during burning is reabsorbed during the next growing season. However, crop residue burning is a significant net source of CH_4, CO, NO_x, and N_2O.

The amount of agricultural wastes produced varies by country, crop, and management system. In Egypt, more than 25 million ton of crop residues are burned annually. Burning is the major disposal method for rice and sugar cane residues in Egyptian farming system.

Two separated years of annual production of the major field crops (wheat, broad been, maize, cotton, rice and sugar cane) depends on burning to disposal its residues, were obtained from FAO Statistics Division 2014 (FAOSTAT, 1999 and 2012).

Total emissions of CH_4 from field burning of agricultural residues increased from 64.67 Gg in year 1999 to 69.44 Gg in year 2005. Meanwhile, it increased in 2012 to be 70.31 Gg. Moreover, N_2O emissions from the same source increased from 0.94 Gg in 1999 to 1.01 Gg in 2005 and 1.03 Gg in 2012. Burning is the major disposal method for rice and sugar cane residues in Egyptian farming system. Therefore, rice and sugar cane were the main sources of emissions of field burning emissions. Figure (II.37) shows the comparison between the different gas emission from crop burning residues in year 2005 and average period of 1999-2012.

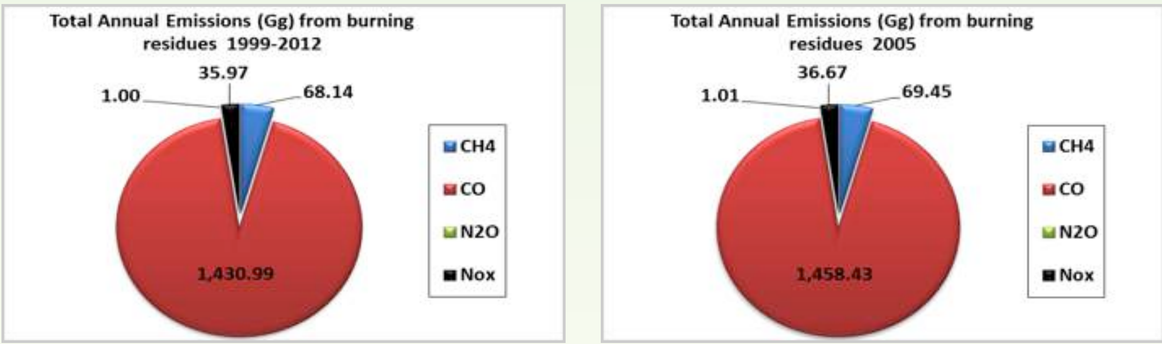


Figure (II.37): Total GHG emissions from crop residues burning

II. 3. 5. Waste Sector

The Waste category includes emissions from the treatment and disposal of wastes. Sources include solid waste disposal on land, wastewater treatment, and waste incineration. Emissions estimated are CH_4 emissions from solid waste disposal on land, CH_4 and N_2O emissions from wastewater treatment, and CO_2, CH_4, and N_2O emissions from waste incineration. The most important gas produced in this source category is methane (CH_4). Table (II.26) summarizes the Waste Sector and source categories contributions for inventory years between 2000 and 2005. Figure (II.38) shows the relative weight of different waste source categories for GHG emissions in 2005.

Table (II.26): Total CO2e emission from waste sector (Gg/y)

Source Category / Year	Solid waste	Wastewater	Incineration	Total
2000	9,330	5,936	5.86	15,272
2001	9,736	6,232	5.99	15,974
2002	10,172	6,557	6.13	16,735
2003	10,620	6,913	6.26	17,539
2004	11,068	7,281	6.4	18,355
2005	11,526	7,665	6.54	19,198

Figure (II.38): Relative weight of different waste source categories for GHG emissions, 2005

II.3.5.a. Methodological Approach and Data Sources

The Revised 1996 IPCC Guidelines provide two methodologies for estimating emissions from ***Solid Waste Disposal Sites*** (SWDS): theoretical gas yield methodology and first order kinetics methodology. The methodology of choice is the first order kinetics methodology, which is also the default methodology in the IPCC guidelines. However the equation used is from the according to the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (Equation 5.1) to count for the normalization factor ‘A’.

Governorates, Giza, Kafr El Sheikh, Damietta, Aswan, Assiut, South Sinai and Port Said, failed to complete the questionnaire about the quantities of MSW generation and collection. For those, values of daily MSW generations are obtained from the Egypt Report on the Solid Waste Management (SWEEPNET, 2010). Governorates, Cairo, Alexandria, Qena, Sohag, Luxor, El Menia, showed inaccuracies in the obtained questionnaire as the MSW collected exceeded the quantity of MSW generated for the same year. For those governorates, value of MSW generation in year 2010 specific for each governorate is obtained from the Egypt Report on the Solid Waste Management (SWEEPNET, 2010). After that, a growth rate of 3.4% is used to extrapolate the MSW generation for the years 2000 to 2005.For the governorates for which the collected waste was higher than the generated amount from the data of the Ministry of Local development and from the Egypt Report on Solid Waste Management, it was assumed that generated waste for the year is equal to the collected waste for the same year. This assumption was applied to the governorates Wady El Gadeed, North Sinai, BaniSwaif and El Menia.

Methane production from ***wastewater handling*** (WWH) under anaerobic conditions is from two sources: industrial and domestic. Data regarding industrial wastewater is very limited. As a result, estimates of the quantities of industrial wastewater provided in the previous inventory were used and extrapolation was done for values beyond 2000. Default IPCC emission factors were used and assumption of treated versus untreated wastewater was modified to reflect reality.

The domestic wastewater handling in Egypt falls under the responsibility of two entities: the Holding Company of Water and Wastewater and the National Institution for Water and Wastewater. The number of wastewater treatment plants (WWTP) has increased over the years. The total population is estimated at 2005 to be 70.1 million while only 26 millions are served in wastewater treatment plants.

The domestic wastewater sources are categorized into 2 groups:

- **Group (i):** Population served by centralized wastewater treatment plants according to data from Holding Company of Water and Wastewater and the National Institution for Water and Wastewater. Country specific MCF is used (if treatment method known). It is assumed MCF = 0.3 (if treatment method unknown assuming overloaded centralized wastewater treatment plant)
- **Group (ii):** Population served by other treatment methods.MCF used is the PCC default.

Group (i) represents the population in the Governorates with available data concerning the number of people served by the centralized wastewater treatment plants as indicated in Appendix I. Group (ii) represents the total population in those Governorates as provided by CAPMAS Egypt minus the population in Group (i). Since the other treatment methods are unknown in Group (ii), the default values for the treatment pathways are used from the IPCC.

Wastewater treatment system/pathway usage differs for rural and urban residents, as well as between urban high-income and urban low-income residents. Handling of wastewater and sludge under anaerobic conditions results in CH_4 production. The extent of CH_4 production depends primarily on the following factors:

- Wastewater characteristics (i.e. BOD, COD, etc)
- Handling Systems (i.e. aerobic ponds, anaerobic lagoons, etc)
- Temperature (i.e. higher than 15°C)
- Other factors (i.e. retention time, degree of wastewater treatment, and other site specific characteristics)

For domestic wastewater, emissions are a function of the amount of organic waste generated and an emission factor that characterizes the extent to which this waste generates CH_4. The Tier 1 method was selected where it applies default values for the emission factor and activity parameters due to the unavailability of relevant data in Egypt. The same method and a constant national increase in industrial production per year are assumed for estimating CH_4 emissions from industrial wastewater for each year resulting in consistent time series. Country specific values have been applied for estimation when data is available. Comparison of country-specific data to IPCC default values as advised by the *Good Practice Guidance.*

The Revised 1996 IPCC and Good practice guidelines were used for estimating CH_4 emissions from the industrial wastewater. It is considered good practice for countries with limited data as Egypt. Sludge and wastewater calculations are not distinguished because of the lack of appropriate statistics that distinguish between them. Data were only available for food and beverage, textiles and pulp and paper industries with no specific data that distinguish the quantities of wastewater from the quantities of sludge.

The emissions of N_2O from human sewage are calculated as follows according to the 1996 IPCC guidelines: The method followed in the 1996 IPCC guidelines is based on protein intake per capita, as it is considered closely linked to the agricultural N cycle. The same method is used for estimating N_2O emissions from domestic wastewater for each year resulting in consistent time series.

As for clinical waste, .default values from IPCC 2006 guidelines for the fraction of carbon in clinical waste, fraction of fossil carbon and emissions factors were used.

According to the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, emissions from CH_4 are not likely to be significant because of the combustion conditions in incinerators e.g. high temperatures and long residence times.

Normally, emissions from CO_2 from waste incineration are significantly higher than NO_2 emissions. Nitrous oxide is emitted in combustion processes at relatively low combustion temperatures between 500 and 950 °C. As indicated in table (5.7) in Good Practice Guidance, it is not applicable to use the reported N2O emission factors for incinerating the clinical waste. Therefore, N_2O emissions from clinical waste incineration are not estimated.

II. 3. 5. b. Solid Waste Disposal on Land

In previous editions of the IPCC Guidelines (1995), solid waste disposal sites were characterized as “open dumps” or “sanitary landfills,” however in the Revised 1996 IPCC Guidelines due to the unclarity of the distinction between landfills and open dumps, all sites at which solid waste is deposited to land are defined as “solid waste disposal sites” (SWDSs). In this sub-section, the emissions are estimated from two types of solid waste disposal methods on land:

- Solid Waste Disposal Sites (SWDS) – collected solid waste
- Managed SWDS
- Unmanaged SWDS
- Uncategorized: uncollected solid waste abandoned in unrecognized sites

SWDSs are categorized into two types according to management practices: managed and unmanaged sites. As to the uncategorized solid waste, it is the uncollected waste abandoned on unrecognized sites. The percentage of collected wastes in Egypt is nearly 69% from the total municipal waste generated (IPCC, 2006). This assumption was only used for governorates that failed to report the amount of collected MSW for each year.

The CH_4 emissions results from the decomposition of organic waste in SWDSs by bacterial action. Due to the heterogeneous nature of SWDSs, there are considerable differences in CH_4 emissions between different SWDSs due to mainly the following influencing factors:

- Waste disposal practices, i.e. degree of control of the placement of waste and management of the site.
- Waste composition, i.e. quantities of degradable organic matter.
- Physical factors, i.e. moisture content, temperature, pH, and nutrient availability.

In the recalculations, an evident discrepancy lies in the quantities reported by the governorates between the Second National Communication (SNC) and the Third National Communication (TNC). In the TNC, the governorates reported MSW generation quantities that are less from the SNC by around 40% in all years. The quantities reported were through the official questionnaire regarding the MSW generation per year that was sent out in 2012 through the Ministry of Local Development.

According to Egypt’s Second National GHG Inventory (1900 – 2000), the net CO_2e from methane emissions from all Solid Waste Disposal (collected and uncategorized) were 10,102 Gg in year 2000. The recalculation for years 1990 - 2005 resulted in net CO_2e of 7,207 Gg. Thus, the recalculations for total emissions from Solid Waste Disposal resulted in about 30% decrease in total emissions in TNC from emissions reported in the 2000 inventory year submission due to lower quantities of MSW generated and collected from each governorate.

Table (II.27) and figure (II.39) show the trend in GHG emissions for solid waste disposal from 1990 to 2005.

Table (II.27): Total CO2e emission from solid waste disposal on land (Gg/y)

Source Category	1990	1995	2000	2001	2005
Managed SWDS	0	0	472	819	2363
Unmanaged SWDS	23	124	324	447	924
Uncategorized	6532	7640	8533	8469	8239
Total	**6554**	**7764**	**9330**	**9736**	**11526**

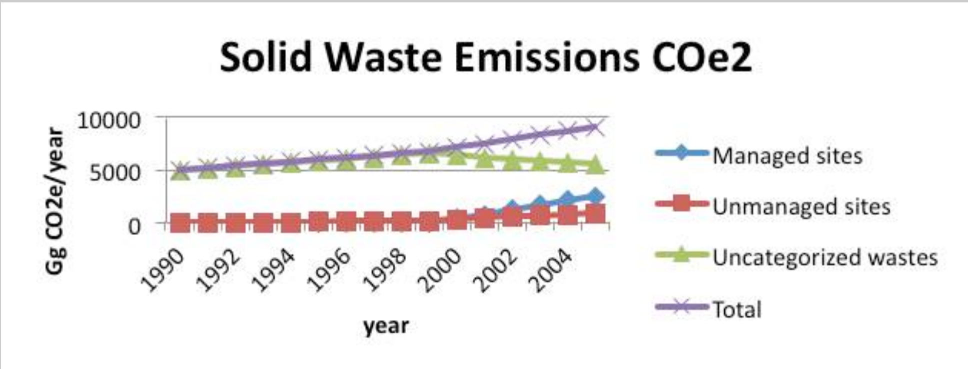


Figure (II.39): Total CO2e emission from solid waste disposal on land (Gg/y)

II. 3. 5. c. Wastewater Handling

The treatment of urban wastewater and the resulting wastewater sludge is accomplished using aerobic and/or anaerobic processes. During the treatment, the biological breakdown of Degradable Organic Compounds (DOC) as well as nitrogen compounds can lead to methane (CH_4) and nitrous oxide (N_2O) emissions, respectively. The discharge of effluents subsequently results in indirect N_2O emissions from surface waters due to the natural breakdown of residual nitrogen compounds. The source category also includes the CH_4 emissions from anaerobic industrial wastewater treatment plants (WWTP) and from septic tanks, but these are small compared to urban WWTP. Methane (CH_4) and nitrous oxide (N_2O) emissions from wastewater are considered under this source category.

According to Egypt's Second National GHG Inventory, the net methane emissions from Industrial Wastewater Handling for the year 2000 were estimated at 184.81 Gg. The recalculation for the same year resulted in net methane emissions of 194.43 Gg. The difference is due to the used value of the COD from textiles industry. A value of 0.09 kg COD/m^3 wastewater was used similar to the default value of Greece in 1996 guidelines. For the TNC, a value of 0.9 kg COD/m^3 wastewater as indicated in Good Practice Guidance is used.

Moreover, according to Egypt's Second National GHG Inventory, the net methane emissions from Domestic Wastewater Handling for the year 2000 were estimated at 90.67 Gg. The recalculation for years the same year resulted in net methane emissions of 88.09 Gg. The negative difference is attributed to the lack of data about the treatment pathways in the earlier submission, which was enhanced to be more realistic during this submission.

The source of Nitrous oxide (N_2O) emissions is from human sewage that is discharged into aquatic environments and is generated due to nitrification and de-nitrification processes. According to Egypt's Second National GHG Inventory, the N_2O emissions from Sewage Sludge for the year 200 were estimated at 0.00965 Gg. The recalculation for years the same year resulted in N_2O emissions of 0.00936 Gg. The difference is attributed to the enhancement done for the collected data to be more realistic during this submission.

Table (II.28) and figure (II.40) show the GHG emissions from wastewater handling for domestic wastewater, human sewage, industrial wastewater and the overall total from 1990 to 2005.

Table (II.28): Total CO2e emission from wastewater handling (Gg/y)

Source Category	1990	1995	2000	2005
Domestic wastewater	1,527	1,681	1,850	2,120
Human sewage	2	3	3	3
Industrial wastewater	2,216	3,008	4,083	5,542
Total	**3,746**	**4,692**	**5,936**	**7,665**

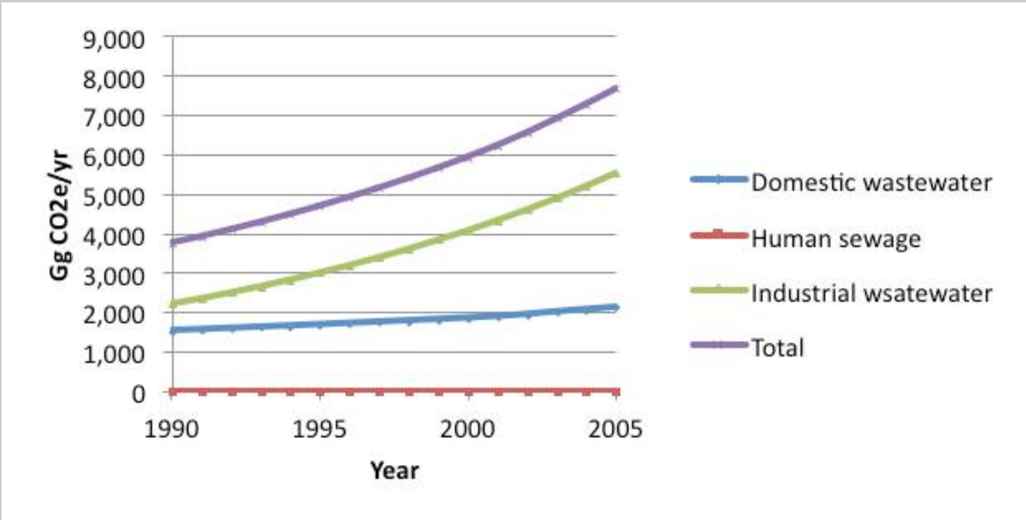


Figure (II.40): Total CO2e emission from wastewater handling (Gg/y)

II. 3. 5. d. Incineration

Waste incineration, like all combustion processes, can produce CO_2, CH_4, CO, NO_x, N_2O and NMVOCs. In Egypt, waste incineration is mostly done for clinical waste. Regarding GHG emissions, only CO_2 emissions resulting from oxidation of carbon in waste of fossil origin (e.g., plastics, certain textiles, rubber, liquid solvents, and waste oil) are considered net emissions and included in the national CO_2 emissions estimate. The CO_2 emissions from combustion of biomass materials (e.g., paper, food, and wood waste) contained in the waste are biogenic emissions and are not included in the estimates.

The total emissions from incineration for 2005 were 0.006 Mt CO_2e, representing 0.02% of the emissions of the waste sector. According to Egypt's Second National GHG Inventory 1999/2000, the CO_2 emissions from incinerating clinical waste were estimated at 3.08 Gg. The recalculation for years 1999/2000 resulted in CO_2 emissions of 5.86 Gg. The difference is attributed to the enhancement done for the collected activity data.

Table (II.29) and figure (II.41) show the total GHG emissions from incineration from 1990 to 2005.

Table (II.29): Total CO_2e emission from incineration (Gg/y)

Year	1990	1995	2000	2005
Incineration	4.50	5.18	5.86	6.54

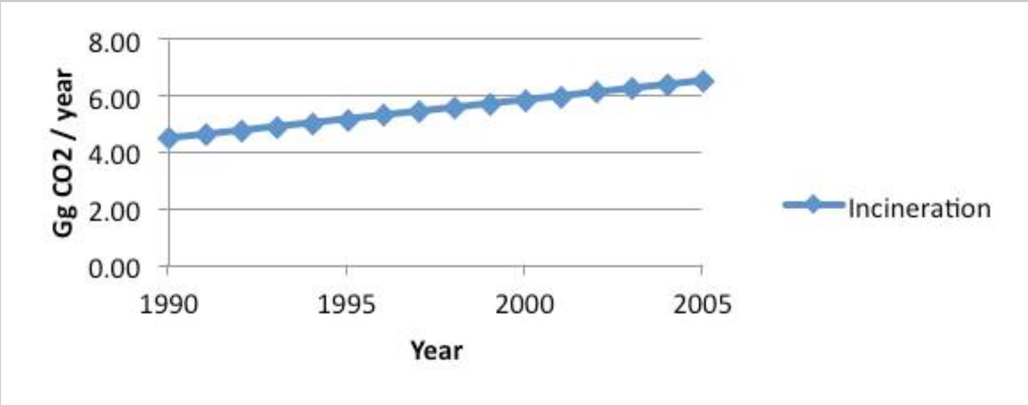


Figure (II.41): Total CO2e emission from incineration (Gg/y)

II. 3. 5. e. GHG for Waste Sector by Gas

As mentioned in the above section (II.3.5.d), all carbon dioxide (CO_2) emissions generated from the waste sector are from the incineration and follow the trend in figure (II.41). Methane emissions from the different waste sectors from 1990 to 2005 are shown in table (II.30) and figure (II.42). As for nitrous oxide, it is mainly emitted from human sewage as shown in table (II.31) and figure (II.43).

Table (II.30): Total CH4 emissions (Gg/y)

Source Category	1990	1995	2000	2005
Solid waste	312	370	444	549
Wastewater	178	223	283	365
Incineration	0	0	0	0
Total	**490**	**593**	**727**	**914**

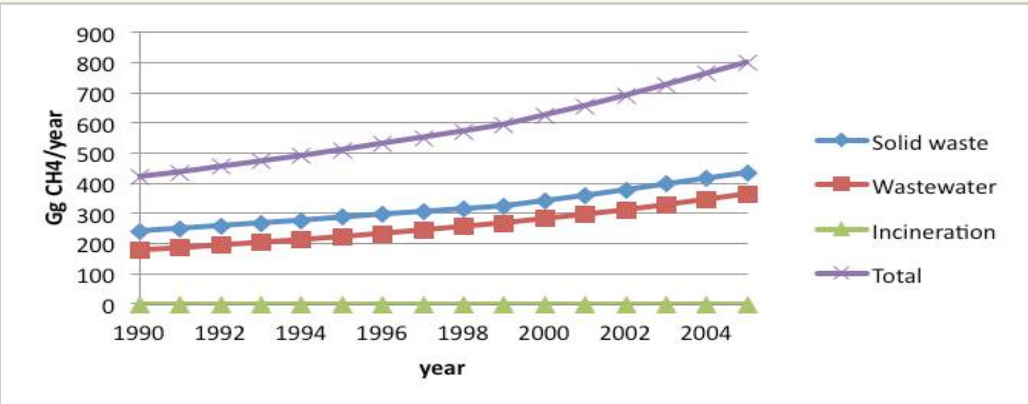


Figure (II.42): Methane emissions for waste sector from 1990 to 2005

Table (II.31): Total N_2O emissions (Gg/y)

Source Category	1990	1995	2000	2005
Human Sewage	0.0077	0.0085	0.0094	0.0103

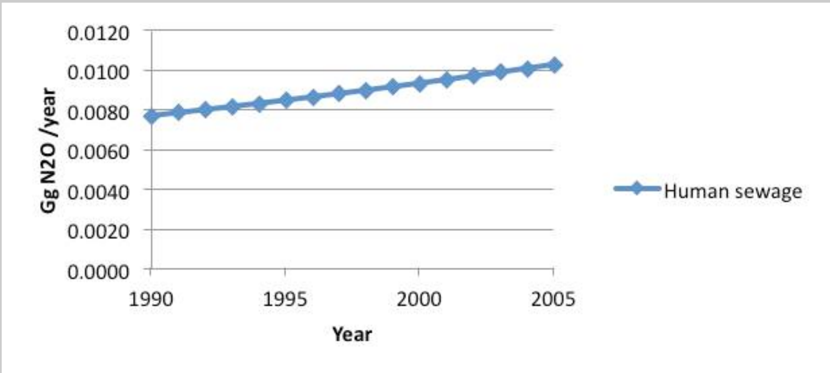


Figure (II.43): Nitrous oxide emissions from human sewage from 1990 to 2005

II.4. SUMMARY

Table (II.32) presents a summary of Egypt's inventory for the year 2005. Total greenhouse gas emissions for 2005 amounted to about **247.97 Mt CO2e.** This is the total of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), PFCs, HFCs, SF6 from the energy (combustion and fugitive emissions) , industry (industrial processes), agriculture and waste sectors.

The energy sector was the largest contributor to greenhouse gas emissions in Egypt. This is mainly because Egypt is highly dependent on fossil fuels, namely oil and natural gas; thus carbon dioxide is the main greenhouse gas emitted. Emissions have been estimated excluding CO_2 emissions from biomass burned for energy. Also, activity data for emissions of non-CO_2 gases from biomass burned for energy were not estimated, considering that using the potential of biomass resulting from agriculture residues and livestock are to be treated under agriculture or waste sector.

Emissions of CO_2e from the energy sector for the base year 2005/2006 are **147,324 Gg**. Methane emissions are 4.120Gg, and N_2O emissions are 0.180Gg. Emissions of CO_2e from the Electricity Sector for the base year 2005/2006 are 54,845.6 Gg. - The percentage of GHGs emissions of the Electricity Sector relative to all energy consumption for CO_2e for the base year 2005/2006 is 37.23%.

The second highest contributor to GHG emissions is industrial production which accounts for **42,013 Gg**. Carbon dioxide gas emitted from cement production is the main contributor with 16,717 Gg followed by ozone depleting substances (HFC's and PFC's) with 15,473 Gg. Nitric acid production responsible for nitrous oxide emissions contributes by 5,042 Gg. Other activities which contribute insignificantly to this sector is ammonia production, iron and steel as well as lime production all producing carbon dioxide emissions. Another minor contributor is aluminum production emitting PFCs.

GHGs from the agriculture sector come next with a contribution of **39,446 Gg**. Agricultural soil is the main source of GHGs emissions from agriculture sector by contribution of 50.75% in 2005. Enteric fermentation is the second important source by contribution of 22.8% in 2005 followed by rice cultivation by contribution of 11.73%. These are followed by manure management by contribution of 10.18% and finally, the field burning of agricultural residue by contribution of 4.43% in 2005.

Finally, the waste category includes emissions from the treatment and disposal of wastes and amounts to **19,198 Gg**. Sources include solid waste disposal on land, wastewater treatment, and waste incineration. Emissions estimated are CH_4 emissions from solid waste disposal on land, CH_4 and N_2O emissions from wastewater treatment, and CO_2 emissions from waste incineration. The most important gas produced in this source category is methane (CH_4).

Table (II.32): Summary of GHG emissions for Egypt, 2005

GHG Source & Sink Categories	CO_2 (Kt)	CH_4 (Kt)	N_2O (Kt)	PFCs (Kt)	SF_6 (Kt)	ODs (HFCs& PFCs) (Kt)	Total (Mt CO_2e)
All Energy (Combustion and Fugitive emissions)	**147,178**	**4.12**	**0.18**				**147.324**
Petroleum	78,175	2.89	0.12				78.275
Natural Gas	69,003	1.23	0.06				69.050
Industrial Processes	**20,420**		**16.26**	**0.16**		**4.81**	**42.013**
Cement production	16,716						16.716
Lime production	202.84						0.203
Iron and steel industry	1,576						1.576
Ammonia not used in Urea	1,924						1.924
Nitric acid production			16.26				5.042
Aluminum production				0.16			1.077
Ozone Depleting Substances, (ODS Substitutes, HFC's & PFC's)						4.81	15.473
Agriculture		**686.8**	**79.89**				**39.446**
Enteric Fermentation		394	-				9.06
Manure Management		27.8	11.26				3.973
Rice Cultivation		201.58					4.63
Agricultural Soils							20.02
Field Burning of Agricultural Residues		63.41	0.99				1.75
Waste	**6.54**	**914**	**0.0103**				**19.19**
Solid Waste		549					11.52
Wastewater		365	0.0103				7.665
Incineration	6.54						0.006
Total GHG Emissions in Mt CO_2e	**167.604**	**34.990**	**28.744**	**1.077**		**15.473**	**247.97**