الجمهورية اللبنانية
مكتب وزير الدولة لشؤون التنمية الإدارية
مركز مشاريع ودراسات القطاع العام

REPUBLIC OF LEBANON

THE MINISTRY OF ENVIRONMENT

Republic of Lebanon
Office of the Minister of State for Administrative Reform
Center for Public Sector Projects and Studies
(C.P.S.P.S.)

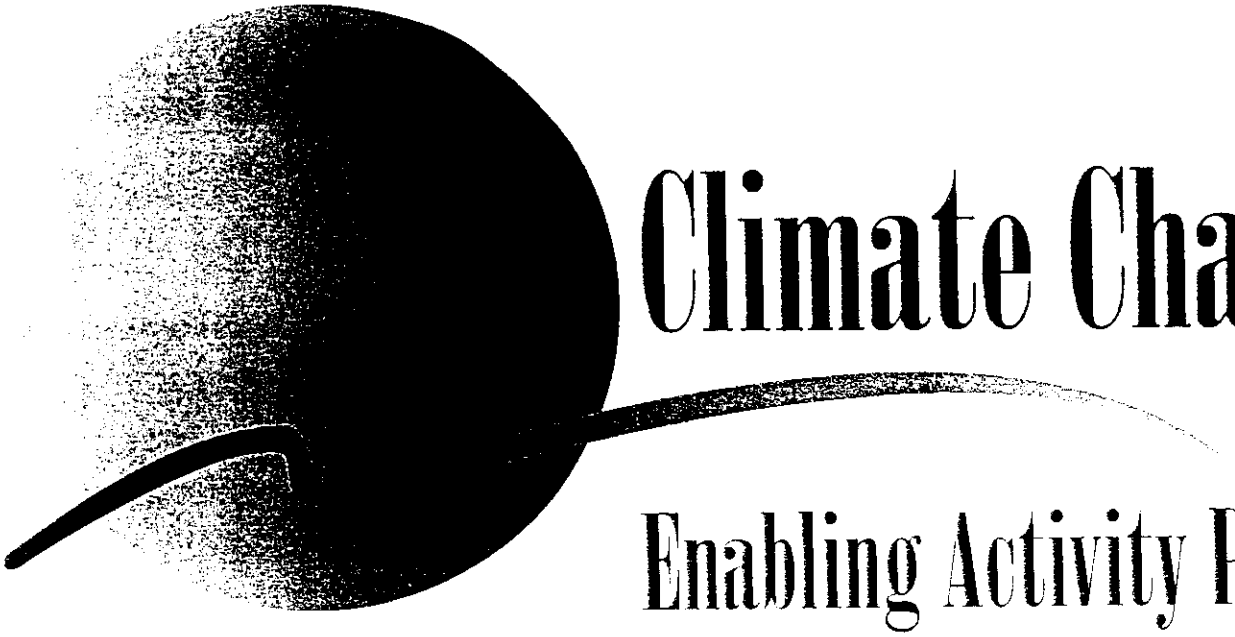
THE FIRST NATIONAL INVENTORY OF SOURCES AND SINKS OF GREENHOUSE GASES

DRAFT REPORT

undp

GLOBAL ENVIRONMENT FACILITY

PROJECT NO: LEB/95/G32



Climate Change

Enabling Activity Project

UNEP
Collaborating Center on Energy and Environment

RISO
National Laboratory

NCSR
National Council for Scientific Research

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LIST OF SYMBOLS

The following abbreviations and symbols are used in this report

CH_4	methane
CO	carbon monoxide
CO2	carbon dioxide
EDL	Electricite du Liban
GHG	green house gases
MHWR	Ministry of Hydraulic and Water Resources
MoP	Ministry of Environment
MoT	Ministry of Transport
NMVOC	non-methane volatile organic compounds
NOx	oxides of nitrogen
N2O	nitrous oxide
RPTA	Railways and Public Transport Authority
SO2	sulfur dioxide
Gg	Gigagram
GNP	Gross National Product
HFC & PFC	Halocarbons
IPCC	Intergovernmental Panel on Climate Change
Kgs	Kilograms
Ltrs	Liters
M	Meter
Mm	Millimetre
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
DOC	Degradable Organic Carbon
MSW	Municipal Solid Waste
GORS	General Organization for Remote Sensing(Syria)
NCSR	National Council for Scientific Research

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INTRODUCTION

I-PROJECT BACKGROUND

In June 1992, in Rio de Janeiro, Brazil, Lebanon was among the 155 countries which have signed a Framework Convention on Climate Change, which ultimate objective is " to achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climatic system", as described in Article 2 of the convention.

Lebanon ratified the convention on December 15, 1994 and thus became a party to the convention, a Non Annex I party, i.e a developing country as specified by the convention.

In accordance with Article 4 of the convention, all parties shall develop, periodically update, publish and make available to the conference of the parties, in accordance with Article 12, national inventories of anthropogenic emissions by sources and removal by sinks of all greenhouse gases not controlled by the Montreal Protocol, using comparable methodologies to be agreed upon by the conference of the parties.

The conference of the parties, on its second session held at Geneva in July 1996, has decided that the guidelines for the national greenhouse gas inventories adopted by the IPCC should be used by Non Annex I parties in the fulfillment of their commitments under the convention, taking year 1994 as a baseline year for the provision of the data.

This present first greenhouse gas inventory has been developed in accordance with the revised 1996 IPCC guidelines, with 1994 as a baseline year. This activity, the main part of Lebanon's First National Communication to be submitted in year 1999, has been achieved under the Climate Change Enabling Activity project. This project is funded by UNDP/GEF and implemented at the Ministry of Environment. This nationally executed project builds capacity in Lebanon to fulfill its communication requirements to the UNFCCC and respond to the objectives of the convention on continuing basis.

II-THE NATIONAL INVENTORY TEAM

According to the project document, the implementation of the inventory activity has been allocated to the National Council for Scientific Research. The National Council, in coordination with the project manager, has formed a team consisting of local experts from various institutions, to undertake this activity according to the IPCC guidelines.

Following, table 1 presents the experts' names along with their relevant sector's responsibility.

Table 1- Inventory team members name list

SECTORS	NAME	ADDRESS	INSTITUTION AND POSITION
INDUSTRIAL PROCESSES	Dr Riad Chedid	03-647330 Fax –01-744462 e-mail: rchedid @ aub.edu.lb	Associate Professor Electrical; Engineer AUB
INDUSTRIAL PROCESSES	Dr Nisrine Ghaddar	Office-01-350000 Ext-3590	Associate Professor Mechanical Engineer AUB
ENERGY	Dr Farid Chaaban	03-706474 e-mail: fbchaban@aub.edu.lb	Associate Professor Electrical Engineer AUB
Assistant to the energy and industrial processes sectors	Mr. Kamal Badeddin	01-373032/3	Manager of scientific research center(Needs)
TEAM LEADER	Dr Khaled Zahraman	01-840319 Fax-01-840315 e-mail-naec@cnrs.edu.lb	NCSR Researcher
WASTE	Dr Mutasem EL Fadel	03-228338 Fax-01-744462 e-mail-mfadel@aub.edu.lb	Associate Professor Env Engineer AUB
LAND USE CHANGE AND FORESTRY	Mrs Theodora Haddad	01-409845\6 Fax-01-409847 e-mail-rsensing@cnrs.edu.lb	RA NCSR.
AGRICULTURE	Dr Maher Kodeih	01-460301 07-731083 Fax-01-960502	ProfessorAssistant LU
Assistant to the land use change and forestry sector	Dr. Mohammad Al Rifai	01-460301 01-305466 Fax: 01-351485	Associate Professor Chemist LU

DESCRIPTION OF LEBANON

The Lebanese republic is situated along the Mediterranean coast of west Asia and covers a land area of around 10452 square kilometers. Lebanon has an estimated population of 3.7 million and an annual growth rate of 2.15%. About 65% of the total population is concentrated in eight principal urban areas.
The country's official language is Arabic but French and English are widely used.
The physical geography of Lebanon is complex and varied. Landforms, climate, soils and vegetation undergo sharp changes within short distances. Four distinct physiographic regions may be distinguished:
A narrow coastal strip which is 225 km long; the Lebanon Mountains which are mountainous ranges running parallel to the sea, overlooking the narrow coastal plain; the trough-like Bekaa valley, and the Anti-Lebanon(Hermon) mountain range running parallel to the coastal mountains.
Lebanon is included in the Mediterranean climatic region. It's climate is generally subtropical, characterized by hot dry summers and mild humid winters. Nearly all precipitation falls in winter averaging 750 to 1000 millimeters on the coast, rising to more than 1000 millimeters in higher altitude. Al Bekaa is dryer and receives about 700 millimeters. On the mountain tops, this precipitation falls as snow and covers the higher elevations till early summer.

EXECUTIVE SUMMARY

I-INTRODUCTION

The structure of the present greenhouse gas inventory report follows the order established in the "Revised 1996 IPCC Guidelines-Greenhouse Gas Inventory Workbook, Volume 2", which has identified six major economic sectors, as follows:

- Energy
- Industrial processes
- Solvent and other product use
- Agriculture
- Land use change and forestry
- Waste

These guidelines have considered the following greenhouse gases:

- CO_2, carbon dioxide
- CO, carbon monoxide
- Nox, nitrogen oxides
- N_2O, nitrous oxide
- SO_2, sulfur dioxide
- CH_4, methane
- NMVOCs, non methane volatile organic compounds
- HFCs, hydrofluorocarbons
- PFCs, perfluorocarbons
- SF_6, sulfur hexafluoride

It should be noted that the protocol developed for the United Nations Framework Convention on Climate Change, in the Conference Of Parties 3, held in Kyoto on December 10, 1997 has determined six greenhouse gases to be controlled, which are:CH_4, CO_2, N_2O, HFC, PFC, SF_6.

In this report, each sector starts with an introduction presenting the state of each sector in Lebanon, followed by the methodology adopted in order to compute emissions of greenhouse gases by sources and removals by sinks, in accordance with IPCC guidelines, complemented by experts' assumptions in estimating greenhouse gases and finallly accompanied by the IPCC sectoral tables which present the result obtained in each sector. The report ends with an "Appendices " chapter which includes all IPCC Volume 2 worksheets, showing the computations made resulting in emitted or removed greenhouse gas quantities.

This executive summary described in the IPCC summary tables 7A and 7B and table 8A showing the quantity of the estimates calculated, presents the main results obtained in each sector. In the last paragraph, the global warming potential of the greenhouse gases emitted in Lebanon in 1994is

provided for three calculated time horizons, based on the "1995 IPCC technical summary of working group I" report.

In order to provide a summary picture of all important results obtained by the National Inventory team, this executive summary hereby presents in table1:

- The emitted amount of each greenhouse gas by sector.
- The total emitted amount of all greenhouse gases in a sector.
- The total amount of each greenhouse gas in all sectors.
- The total quantity of greenhouse gases emitted in Lebanon, in gigagrams.

Following the summary table, charts 1-7 have been developed to show:

- The contribution of various sectors to total CO_2 emissions in Lebanon in 1994(Fig.1)
- The contribution of various sectors to total CH_4 emissions in Lebanon in 1994(Fig.2)
- The contribution of various sectors to total N_2O emissions in Lebanon in 1994(Fig.3)
- The contribution of various sectors to total NOx emissions in Lebanon in 1994(Fig.4)
- The contribution of various sectors to total CO emissions in Lebanon in 1994(Fig.5)
- The contribution of various sectors to total NMVOC emissions in Lebanon in 1994(Fig.6)
- The contribution of various sectors to total SO_2 emissions in Lebanon in 1994(Fig.7)

Table 1 Summary of Greenhouse Gas Emission Inventories for Lebanon (1994)

SECTOR	CO_2	CH_4	N_2O	NO_X	CO	NMV0C	SO_2	TOTAL BY SECTOR
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Energy	11723.6	1.2356	0.9534	46.2639	337.669	59.122	79.8	12248.6
Industry	1951.84	N0	NO	0.01112	0.36188	70.511	3.5346	2026.25
Solvents	NE	NE	NE	NE	NE	NE	NE	
Agriculture		7.6095	3.0147	0.00146	0.04306			10.6687
Land-use Change & Forestry	2279.56	12.5685	0.0864	3.12305	109.974			2405.31
Waste	0	0.0837	0	0	0	0	0	0.0837
I. Total	15955.3	21.497	4.0545	49.3995	448.048	129.63	83.334	**16691**

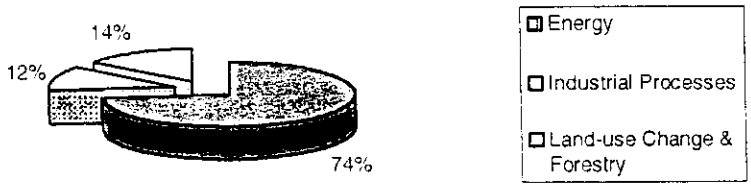

Fig. 1 Contributions of Various Sectors to CO2 Total Emissions in Lebanon (1994)

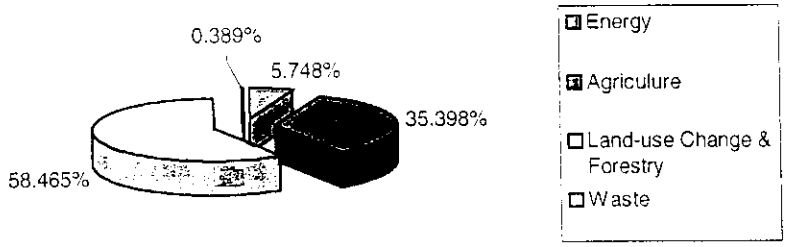

Fig. 2 Contributions of Various Sectors to CH4 Total Emissions in Lebanon (1994)

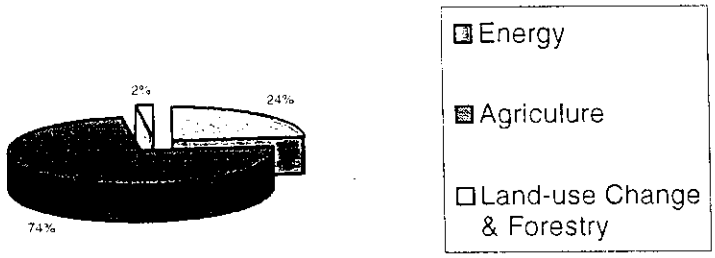

Fig. 3 Contributions of Various Sectors to N2O Total Emissions in Lebanon (1994)

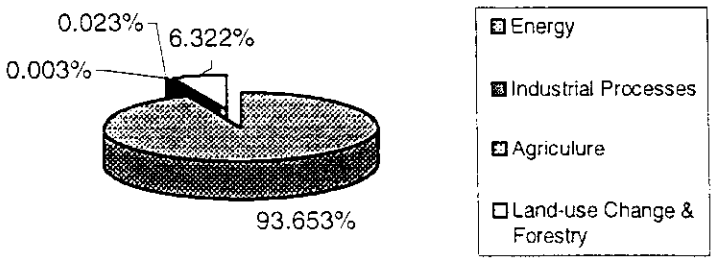

Fig. 4 Contributions of Various Sectors to Total NOx Emissions in Lebanon (1994)

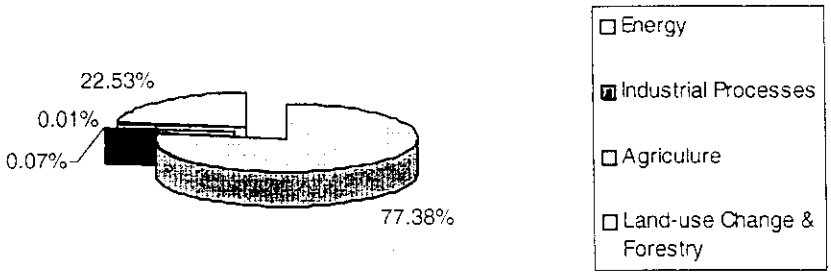

Fig. 5 Contributions of Various Sectors to the Total CO Emissions in Lebanon (1994)

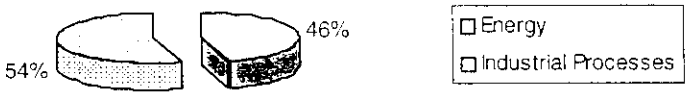

Fig. 6 Contributions of various Sectors to Total NMVOC Emissions in Lebanon (1994)

Fig. 7 Contributions of Various Sectors to Total SO2 Emissions in Lebanon (1994)

In order to convey a concrete picture of the location of the main greenhouse gas sources in Lebanon, maps 1-5 have been built and present the geographical distribution of Lebanon's potential greenhouse gas sources for year 1994:

- Map 1 presents the geographical distribution of the greenhouse gas sources in the Energy sector
- Map 2 presents the geographical distribution of the greenhouse gas sources in the Industrial processes sector
- Map 3 presents the geographical distribution of the greenhouse gas sources in the Land use change and forestry sector
- Map 4 presents the geographical distribution of the greenhouse gas sources in the Agriculture sector
- Map 5 presents the geographical distribution of the greenhouse gas sources in the Waste sector

II-ENERGY SECTOR

The following GHG are of interest in the energy sector: carbon dioxide CO_2, methane CH_4, nitrous oxide N_2O, oxides of nitrogen Nox, carbon monoxide CO, sulfur dioxide SO2 and non-methane volatile organic compounds (NMVOCs). The inventory has focused on the following GHG related sources

1. Electricity generation through the electric utility
2. Private generation of electricity
3. Manufacturing industries and construction
4. Transport: road, domestic aviation, national navigation
5. Energy use in the residential sector
6. Energy use in the commercial/institutional sector
7. Energy use in the agriculture/forestry/fishing sector

The fuel types taken into consideration are: gasoline, jet kerosene, kerosene for household use, gas oil, diesel oil, fuel oil, LPG, lubricating oil, coal, wood and charcoal (under solid biomass). Care has been taken to eliminate the fuel used by international marine and aviation bunkers from the national inventory.

Finally, it is worth mentioning that both the reference approach and analysis by source categories have been carried out and are reported in this inventory.

The total amount of liquid secondary fuels that was imported to Lebanon in 1994 is 4107883Tons. The use of solid fuel and biomass fuel is minor and confined to the use of 160000 Tons of wood, 1560 Tons of charcoal and 180000 Tons of coking coal. Data on international bunkers in Lebanon were restricted on International aviation because the amount of fuel that goes on international marine has never been documented and is believed to be minor. Domestic aviation is almost non existent in Lebanon and therefore all imported jet kerosene goes on international aviation except for 1910 Tons used by few training planes.

Tables 2-5 provide information on fuels used and GHG emissions by fuel source, by fuel type, by sector and by non-CO_2 emissions.

Table 2. Summary of CO_2 emissions by fuel source

FUEL TYPE	CONSUMPTION, TJ	CO_2 , Gg
Gasoline	55694.5536	3821.035
Jet kerosine	85.1669	6.028539
Kerosene	4.475	0.318387
Gas/diesel oil	35449.03787	2599.336
Fuel oil	56708.6523	4343.485
LPG	6907.2602	426.9053
Lubricants	11154.9187	404.9235
Coking coal	5040	116.812
Municipal solid wastes	64.995	4.765823
Charcoal	46.64	5.363438
Wood (Solid Biomass)	4784	550.0962
International Bunkers	6420.96	454.5076

Table.3 Summary of CO_2 emissions by fuel type

FUEL TYPE	CONSUMPTION, TJ	CO_2 , Gg
Total liquid fuel	166069.25	11606.814
Total solid fuel	5040	116.812
Total biomass	4830.64	555.45963

Table.4. Summary of CO_2 emissions by sector

SECTOR	CO_2 , Gg
Energy Industries	3903.9966
Manufacturing Industries and Construction	2533.8056
Transport	3957.1245
Commercial/Institutional	225.88433
Residential	530.95774
Agriculture/Forestry/Fishing	571.8575
International Bunkers	454.50765

Table.5. Summary of non-CO_2 emissions (Gg) by sector.

SECTOR	CH_4	N_2O	NO_X	CO	NMVOC	SO_2
Energy Industries	0.169222	0.033844	11.281501	0.846112	0.282037	45.021676
Manufacturing Industries and Construction	0.121858	0.028493	8.6578949	0.357294	0.279447	24.667302
Transport						
Road	0.7835	0.024303	24.657609	311.6343	58.45359	2.67669
Domestic Aviation	4.2583×10^{-5}	0.000170	0.025550	0.008567	0.004258	0.001872
Domestic Navigation	9.11×10^{-5}	1.094×10^{-5}	0.0273406	0.018227	0.003645	
Commercial/Institutional	0.02844	0.001568	0.2844034	0.084471	0.015944	1.1305846
Residential	1.4990	0.021408	1.0281585	24.564344	2.915371	2.5790874
Agriculture/Forestry/ Fishing	0.0779	0.004679	0.7798836	0.1559767	0.038994	3.5281052
Total	1.23567	0.095343	46.26394	337.6692	59.1228	79.6053
International Bunkers	0.0032105	0.0128419	1.926288	0.642096	0.321048	0.14134

III-INDUSTRIAL PROCESSES SECTOR:

In 1994, Lebanese Industry has emitted 1951.841 Gg (1,951,841 Tonnes) of carbon dioxide, 0.361884 Gg (361884 Tonnes) of carbon monoxide, 0.01112 Gg of nitrogen oxide, 70.5114 Gg (70,511.4 Tonnes) of non-methane volatile organic compounds and 3.5346 Gg (3534.6 Tonnes) of sulphur dioxide.

The cement industry is the major source for CO_2 emissions from the industrial processes in Lebanon. Cement industry is responsible for 76.1% of the total emissions of the industrial processes followed by the iron and steel industry which produces 22.8% of the total CO2 emissions from industrial processes. Fig. 8 shows the percentage distribution of various industrial sources contributions to CO_2 emissions in Lebanon.

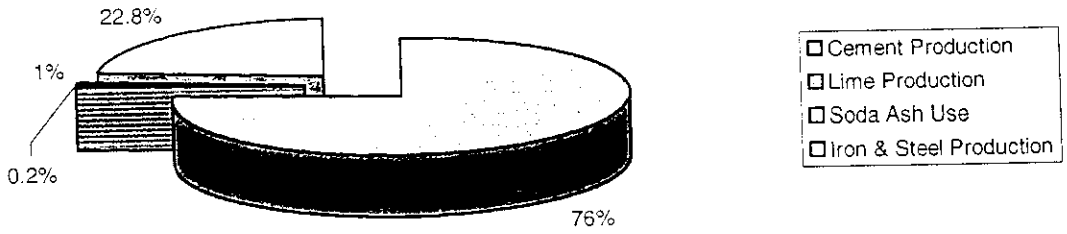

Fig. 8 CO_2 Emissions from Industrial Sources

The NMVOC emissions are mainly produced by the use of asphalt for road paving (95% of total emissions by industry) followed by the food and drink industry (4.88%). Fig.9 shows the percentage distribution of various industrial sources contributions to NMVOC emissions in Lebanon.

The emissions of sulphur dioxide SO2 come from three industrial sources. The first source is from the production of sulphuric acid (66.8% of total industrial emissions). The second is the cement industry (25.3% of total industrial emissions) and the third is from the iron and steel mills (7.9% of total industrial emissions). Fig. 10 shows the percentage distribution of various industrial sources contributions to SO_2 emissions in Lebanon.

Carbon monoxide emissions in the industrial sector are very small. The major source is iron and steel mills and the other minor source is asphalt-roofing production.

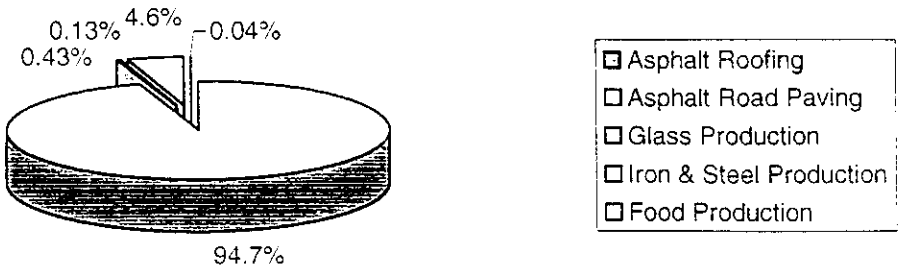

Fig. 9 NMVOC Emissions from Industrial Sources

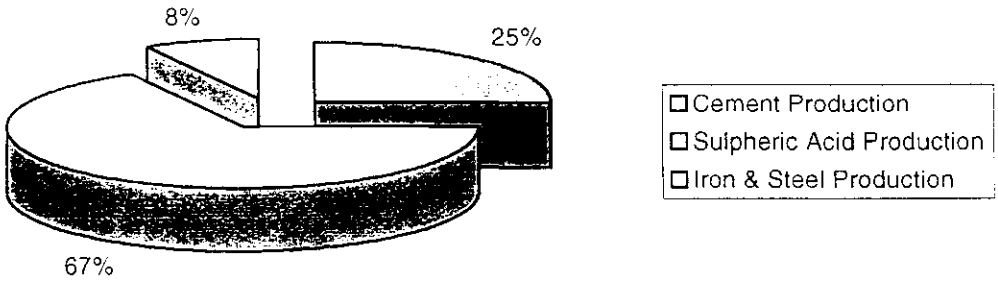

Fig. 10 SO_2 Emissions from Industrial Sources

Uncertainties and limitations are associated with the estimated greenhouse gas emissions. The emissions reported for industrial processes in Lebanon reflect current best estimates. Thus the reported emissions inventory provides a foundation for the development of a more detailed and comprehensive Lebanese inventory in the future. Specific limitations include: a) Quantitative estimates for some sources of greenhouse gas emissions were not always based on data obtained from specific sources, but from bulk imports of certain products; and (b) the accuracy of the inventory estimates relies heavily on emissions factors available from the IPCC Guidelines [1,2]. These factors are used in the Lebanese inventory. These factors may differ for some local industrial processes because of differences in the raw material used.

IV-SOLVENT AND OTHER PRODUCT USE

This category covers mainly NMVOC emissions resulting from the use of solvents and other products containing volatile compounds. It also includes CO_2 and N_2O emissions from anaesthetic and propellant gases. The only relevant part to Lebanon in this sector is the paint applications, degreasing and dry cleaning. However no estimation of GHG was made in this sector due to non availability of data and emission factors.

V-AGRICULTURE SECTOR:

In Lebanon, emission of greenhouse gases from agricultural activities occur through the following processes:

I- Enteric fermentation and manure management of the domestic livestock emits methane and nitrous oxide.

II- Agricultural burning of crop residues is of minor importance since field burning of crop residue is not a common practice in Lebanon.

III- Agricultural soils are a source of nitrous oxide directly from the soils and from animal production, and indirectly from the nitrogen added to the soils.

The following results for the inventory year 1994 are obtained:
7.60955 Gg of methane, 3.01478 Gg of nitrous oxide, 0.00146 Gg of nitrogen oxides, and 0.04306 Gg of carbon monoxide.

VI-LAND USE CHANGE AND FORESTRY SECTOR:

The land use change and forestry considers the following submodules in calculating GHG emission by sources or removal by sinks:

I-Submodule changes in forestry and other woody biomass stocks:

This submodule has presented considerable difficulties in the data collection activity since no information or records are available at the institutional level. Therefore, the data derived represents a large degree of uncertainty.
The stocks of woody biomass needed to calculate the carbon uptake or storage In Lebanon for 1994 were found made of:

a- 75000 ha of forest trees(65000 evergreen and 10000 deciduous)
b- 50280 thousand non-forest trees which include:

1) 49794 thousand trees of farm and village trees(21980000 of evergreen fruit and olive trees and 227814 of deciduous fruit trees)
2) 486 thousand urban trees (45000 evergreen urban trees and 36000 deciduous urban trees)

The total increment by these stocks of woody biomass is 263.80666 kt.
The loss of biomass is limited to 200 kt dm of fuel consumption, since other wood use data are not available.

As a result, the changes in woody biomass stocks in Lebanon is considered as a sink of CO_2 absorbing 6006244 kt of CO_2 for the inventory year 1994.

II- Submodule forest and grassland conversion-CO_2 from biomass:

The natural and man made fires are included in this submodule. In 1994, around 7500 ha of woodland were affected by fires, and the resulting CO_2 released is 2880.2812Gg.

The striking result in this module is that forests for year 1994 constitute a source of CO_2 rather than a sink due to the intensive forest fires. The CO_2 emission from land use change and forestry is 2279.6568 kt.

VII-WASTE SECTOR:

The waste management section of this report deals with two sectors: land disposal of solid waste and wastewater treatment. It provides background information on the type of emissions that contribute to the greenhouse gases from these two sectors, presents the current status in Lebanon of both sectors, describes the methodology followed to estimate the corresponding emissions, and presents the results obtained regarding greenhouse emissions.

The total methane emissions from solid waste disposal on land is 83.7 tonnes (0.0837 Gg) approximately. There are no emissions from wastewater and industrial handling systems because for the target year 1994, there was no treatment facilities in Lebanon. The wastewater (municipal, commercial, and industrial) was directly discharged into the sea, rivers, ravines, or septic tanks which indicate that methane or nitrous oxide emissions are insignificant if not non-existent. Note that this situation will change in the future as treatment plants are being constructed around the country and are expected to come into operation by the year 2,000.

VIII. Relative Impact of Greenhouse Gases Effect: Global Warming Potential (GWP):

The impact of a given quantity of gas in terms of weather warming is measured by its global warming potential (GWP). The GWP is defined as the cumulative radiating forcing between the present and some chosen later time horizon caused by a unit mass of gas emitted now, expressed relative to some reference gas (here CO_2 is used). The future global warming commitment of a green house gas over the reference time horizon is the appropriate GWP multiplied by the amount of gas emitted. The GWP of a

given gas depends mostly on the thermal efficiency of the gas, on various complex physical and chemical parameters and on its life span in the atmosphere as a direct or indirect greenhouse gas. As a rule, three possibilities of integration timespan are used: 20 years, 100 years and 500 years.

The 20 years possibility appears to be too brief for an assessment of high inertia phenomena such as those found in climatology. In addition, the life span of many greenhouse gases is much longer. A 500 years integration time span is very attractive, but gives highly uncertain projections on changes in the physical and chemical phenomena. The intermediate option, 100 years, leads to reasonable analysis and is the most commonly used option.

Table 6 presents the GWP time horizon referenced to the updated decay response for the carbon Cycle Model and future CO_2 atmospheric concentrations held constant at current level.

Table 6 Global warming Potential Time Horizon of Greenhouse Gases

TYPE OF GAS	LIFE TIME	GLOBAL WARMING POTENTIAL* (TIME HORIZON)		
	(years)	20 years	100 years	500 years
CO_2		1	1	1
CH_4	12 ± 3	56	21	6.5
N_2O	120	280	310	170
HFC-134a	14.6	3400	1300	420

***Source: Climate Chang 1995, the Science of Climate Change: Summary for Policy Makers and Technical Summary of Working Group I Report, pg.26.**

With the GWP, the global emissions of the country by sectors can be expressed in the same unit of CO_2 equivalent for the sake of aggregation or comparison. Accounting for the GWP of each greenhouse gas emitted, the CO_2 equivalent for each gas is calculated and the data are summarized in Table 7. Fig. 11 shows also the GWP of greenhouse gases emitted in Lebanon in 1994 for the three calculated time horizons.

The total GWP based on 100 years life span for greenhouse gas emissions in Lebanon is 17665.997 $GgECO_2$ (17.666 $MTECO_2$). If this amount is divided by the Lebanese population for the year of 1994, then the GWP is 4.64 Tonnes Equivalent of CO_2/capita/year.

Table 7 Global Warming Potential of Greenhouse Gases Emitted in Lebanon (1994)

TYPE OF GAS	GAS EMISSION (Gg)	GWP (20 YEARS)	GWP (100 YEARS)	GWP (500 YEARS)
		Gg Equivalent of CO_2 ($GgECO_2$)		
CO_2	15955.03	15955.03	15955.03	15955.03
CH_4	21.4974	1203.8544	451.4454	139.7331
N_2O	4.05459	1135.2852	1256.9229	689.803
HFC-134a	0.002	6.8	2.6	0.82
	Total GWP	**18300.97**	**17665.997**	**16785.3861**

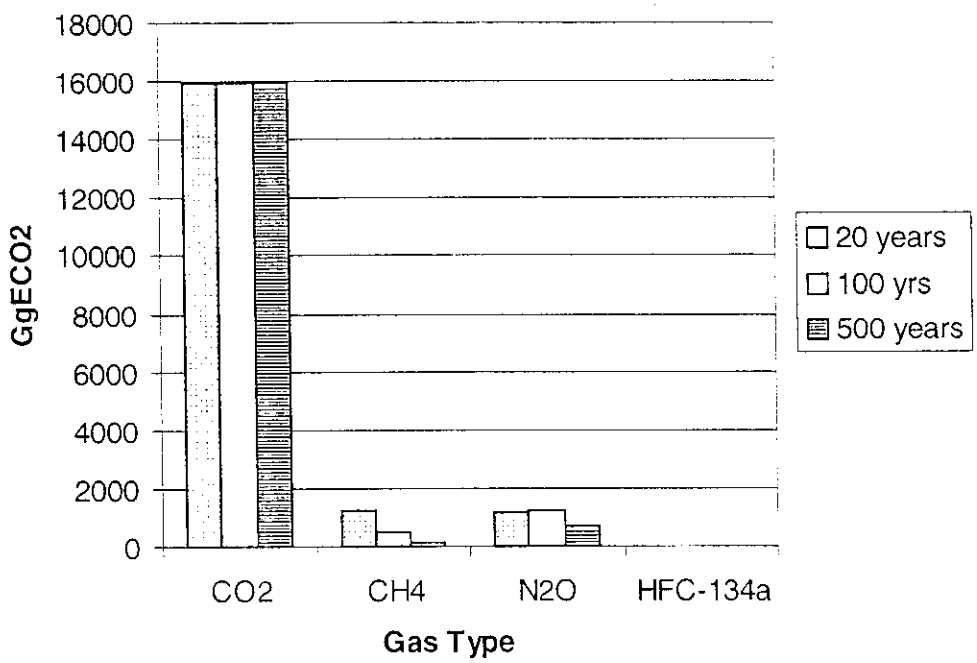

Fig. 11 Global Woarming Potential of Greenhouse Gases in Lebanon (1994)

Table 7A Sectoral Report For National Greenhouse Gas Inventories

(Sheet 1 of 3)

Sectoral Report for National Greenhouse Gas Inventories (Gg)

Green House Gas Source snd Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_X	CO	NMVOC	SO_2	HFCs		PFCs		SF_6	
									P	A	P	A	P	A
Total National Emissions and Removals	16555.9	-600.6	22.989	3.216	49.88	448.35	135.93	83.33	0.002	0	0	0	0	0
1 Energy	11723.8		2.73	0.11	46.74	337.58	61.99	79.80						
A Fuel Combustion														
1 Energy Industries	3904.00		0.16920	0.03380	11.2815	0.8461	0.2820	45.2160						
2 Man Ind. and Construction	2534.00		0.12180	0.02849	8.6579	0.3573	0.2794	24.6670						
3 Transport	3957.13		0.78363	0.02448	24.7105	311.661	58.4600	2.6780						
4 Other Sectors	1328.70		1.65230	0.02763	2.0924	24.7199	2.9703	7.2370						
5 Other(Specify)														
B Fugitive Emissions from Fuels	NO		NO	NO	NO	NO	NO	NO						
1 Solid Fuels	NO		NO	NO	NO	NO	NO	NO						
2 Oil and Natural Gas	NO		NO	NO	NO	NO	NO	NO						
2 Industrial Processe	1951.841		NO	NO	0.0111	0.3619	73.936	3.5346	0.002	0	0	0	0	0
A Mineral Products	1506.921					0.0004	70.4656	0.894						
B Chemical Industry	NO	NO	NO	NO	NO	NO	NO	2.3625						
C Metal Production	444.92				0.0111	0.3615	0.0278	0.2781						
D Other Production	0						3.4428							
E Production of Halocarbons And Sulfur Hexafluoride	0								NO	NO	NO	NO	NO	NO
F Consumption of Halocarbons And Sulfur Hexafluoride	0								0.002	NE	0	NE	0	NE
G Other (Specify)														

Table 7A Sectoral Report For National Greenhouse Gas Inventories

(Sheet 2 of 3)

Sectoral Report for National Greenhouse Gas Inventories

(Gg)

Green House Gas Source snd Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_X	CO	NMVOC	SO_2	HFCs		PFCs		SF_6	
									P	A	P	A	P	A
3 Solvent and Other Product Use	NE	NE	NE	NE	NE	NE	NE	NE						
4 Agriculture	0		7.60955	3.01474	0.00146	0.4306								
A Enteric Fermentation			6.7859											
B Manure Management			0.8216	0.4194										
C Rice Cultivation				0										
D Agricultural Soils				2.5953										
E Prescribed Burning of Savannas			0	0										
F Field Burning of Agricultural Residues			0.00205	0.00004	0.00146	0.4306								
G Other (specify)														
5 Land use Change and Forestry	2880.281	-600.62	12.5685	0.08641	3.12305	109.974	0	0						
A Changes in Forest and Other Woody Biomass Stock		-600.62												
B Forest and Grassland Conversion	2880.281		12.5685	0.08641	3.12305	109.974								
C Abandonment of Managed Lands														
D CO2 Emissions and Removals from Soil														
E Other(specify)														
6 Waste	0	0	0.0837	0	0	0	0	0						
A Solid Waste Disposal on Land	*	0	0.0837	0	0	0	0	0						
B Wastewater Handling	0	0	0	0	0	0	0	0						
C Waste Incineration														
D Other (specify)														
7 Other (specify)														

* IPCC Methodology accounts for CO2 emissions from waste under land use and forestry

Table 7A Sectoral Report For National Greenhouse Gas Inventories

(Sheet 3 of 3)

Sectoral Report for National Greenhouse Gas Inventories (Gg)														
Green House Gas Source snd Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_X	CO	NMVOC	SO_2	HFCs		PFCs		SF_6	
									P	A	P	A	P	A
Memo Items														
International Bunkers														
Aviation	454.507		0.00321	0.01284	1.926	0.642	0.321	0.14134						
Marine	0		0	0	0	0	0	0						
CO_2 Emissions from Biomass	555.459													

Table 7B Short Summary For National Greenhouse Gas Inventories

Sectorial Report for National Greenhouse Gas Inventories (Gg)													
Green House Gas Source snd Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_X	CO	NMVOC	SO_2	HFCs		PFCs		SF_6	
									P	A	P	A	P	A
Total National Emissions and Removals	**15955.03**		**21.4974**	**4.05459**	**49.3995**	**448.048**	**129.634**	**83.3346**						
1 Energy Reference Approach	11723.62													
Sectoral Approach	11723.62	0	1.2356	0.9534	46.2639	337.669	59.1228	79.8						
A Fuel Combustion	11723.62	0	1.2356	0.9534	46.2639	337.669	59.1228	79.8						
B Fugitive Emissions from Fuels	0	0	0	0	0	0	0	0						
2 Industrial Processes	1951.841	0			0.01112	0.36188	70.5114	3.5346	**0.002**		**0**		**0**	
3 Solvent and Other Products	NE			NE			NE							
4 Agriculture	0	0	7.60955	3.01478	0.00146	0.04306								
5 Land-use Change and Forestry	2279.569	*	12.5685	0.08641	3.12305	109.974								
6 Waste	0	0	0.0837	0	0	0	0	0						
7 Other(specify)														
Memo Items														
International Bunkers														
Aviation	454.507	0	0.00321	0.01284	1.926	0.642	0.321	0.14134						
Marine	0	0	0	0	0	0	0	0						
CO_2 Emissions from Biomass	555.459													

P: Potential emissions based on Tier I Approach A= Actual emissions based on Tier 2 Approach

* CO2 removals is included in the net CO2 emissions as a single number.

Table 8A Overview Table For National Greenhouse Gas Inventories

Overview Table

GreenHouse Gas Source And Sink Categories	CO_2		CH_4		N_2O		NO_X		CO		NMVOC		SO_2		HFCs		PFCs		SF_6		Documentatio	isaggregatio	Footnotes
	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality			
Total National Emissions and Removals	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M			
1 Energy	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M									
A Fuel Combustion Activities																							
Reference Approach	ALL	H	ALL	H	ALL	H	ALL	H	ALL	H	ALL	H	ALL	H									
Sectoral Approach	PART	M	PART	M	PART	M	PART	M	PART	M	PART	M	PART	M									
1 Energy Industries	ALL	H	ALL	H	ALL	H	ALL	H	ALL	H	ALL	H	ALL	H									
2 Manufacturng Industries and Construction	PART	M	PART	M	PART	M	PART	M	PART	M	PART	M	PART	M									
3 Transport	ALL	H	ALL	H	ALL	H	ALL	H	ALL	H	ALL	H	ALL	H									
4 Other Sectors	PART	M	PART	M	PART	M	PART	M	PART	M	PART	M	PART	M									
5 Other (specify)																							
B Fugitive emissions from Fuels	NO		NO		NO		NO		NO		NO		NO										
1 Solid Fuels	NO		NO		NO		NO		NO		NO		NO										
2 Oil and Natural Gas	NO		NO		NO		NO		NO		NO		NO										
2 Industrial Processes	ALL	M					ALL	M	ALL	M	ALL	M	ALL	M									
A Mineral Products	ALL	H					0		ALL	H	ALL	H	ALL	H									
B Chemical Industry	0	L					0		0	M	0		2.3625	M									
C Metal Production	PART	M					PART	M	PART	M	PART	M	PART	M									
D Other Production	PART	M									PART	M											
E Production of Halocarbons and Sulphur Hexafluoride															NO		NO		NO				

Table 8A Overview Table For National Greenhouse Gas Inventories

Overview Table

GreenHouse Gas Source And Sink Categories	CO_2		CH_4		N_2O		NO_x		CO		NMVOC		SO_2		HFCs		PFCs		SF_6		Documentation	Disaggregation	Footnotes
	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality			
Continued Industrial Processes																							
F. Consumption of Halocarbons and Sulphur Hexafluoride																							
Potential															ALL	M	0	M	0	M			
Actual															NE		NE		NE				
G Other (specify)																							
3 Solvent and Other Product Use	NE				NE						NE												
4 Agriculture			ALL	M	ALL	M	ALL	M	ALL	M													
A Enteric Fermentation			ALL	M																			
B Manure Management			ALL	M	ALL	M																	
C Rice Cultivation																							
D Agricultural Soils					ALL	M																	
E Prescribed Burning of Savannas																							
F Field Burning of Agricultural Residues			ALL	M	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M									
G Other Specify																							
5 Land-use Change& Forestry	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M													
A Changes in Forest and Other woody Biomass Stock	ALL	M																					
B Forest and Grassland Conversion	ALL	M	ALL	M	ALL	M	ALL	M	ALL	M													
C Abandonment of Managed Lands																							
D CO_2 Emissions and Removals from Soil																							
E Other Specify																							

Table 8A Overview Table For National Greenhouse Gas Inventories

Overview Table

GreenHouse Gas Source And Sink Categories	CO_2		CH_4		N_2O		NO_X		CO		NMVOC		SO_2		HFCs		PFCs		SF_6		Documentation	Disaggregation	Footnotes
	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality			
6 Waste	0		ALL		0		0		0		0		0										
A Solid Waste Disposal on Land	0		ALL		0		0		0		0		0										
B Wastewater Handling	0		0		0		0		0		0		0										
C Waste Incineration																							
D Other Specify																							
7 Other (Specify)																							
Memo Items:																							
International Bunkers																							
Aviation	ALL	H	ALL	H	ALL	H	ALL	H	ALL	H	ALL	H	ALL	H									
Marine	0		0		0		0		0		0		0										
CO_2 Emissions from Biomass	ALL	H																					

SECTOR 1. ENERGY

1.1 INTRODUCTION

The aim of this section is to report the results of the greenhouse gas (GHG) emission inventory for the year 1994. The following GHG are of interest in the energy sector: carbon dioxide CO_2, methane CH_4, nitrous oxide N_2O, oxides of nitrogen NO_x, carbon monoxide CO, sulfur dioxide SO_2 and non-methane volatile organic compounds (NMVOCs). The inventory has focused on the following GHG related sources:

1. Electricity generation through the electric utility.
2. Private generation of electricity.
3. Manufacturing industries and construction.
4. Transport: road, domestic aviation, and national navigation.
5. Energy use in the residential sector.
6. Energy use in the commercial/institutional sector.
7. Energy use in the agriculture/forestry/fishing sector.

The fuel types taken into consideration are: gasoline, jet kerosene, kerosene for household use, gas oil, diesel oil, fuel oil, LPG, lubricating oil, coal, wood and charcoal (solid biomass). Care has been taken to eliminate the fuel used by international marine and aviation bunkers from the national inventory.

The amount of GHG released to the atmosphere has been estimated using the IPCC methodology and emission factors [1,2]. Where national emission factors differed from those of IPCC, the factors are discussed. Complete documentation of compiled information and data sources are attached to this report in the Appendix.

Finally, it is worth mentioning that both the reference approach and analysis by source categories have been carried out and are reported in this inventory.

1.2 ENERGY STATUS IN 1994

The energy sector in Lebanon plays an important role in the overall development of the country. Apart from a modest amount of hydropower and traditional energy (wood and charcoal) which together represent less than 2 % of energy consumption, all energy in Lebanon is derived from imported petroleum products and some coal (160000 T used by two cement factories). Prior to the war, there were two refineries in operation, but both were badly damaged and are currently out of operation [3].

Total consumption of petroleum products in Lebanon in 1994 was 4107880 Tons [3] covering the following types of fuel: gasoline, gas oil, jet kerosene, LPG, fuel oil, bitumen, kerosene for domestic use and lubricants.

I. THE PETROLEUM SECTOR

The petroleum and gas sector is the responsibility of the Ministry of Petroleum (MoP). The executing agency is the Directorate of Petroleum, responsible for licensing import activities, import of crude oil and refining, import of fuel oil, and setting prices for petroleum products. Until 1988, the government retained a monopoly over the petroleum market, but a number of private companies have subsequently been authorized to import and distribute petroleum. A total of 21 companies [3,8] are importing petroleum in addition to the government and large industries. In addition to importing companies, 84 private companies are involved in distribution of petroleum products to 2022 gas stations responsible for the distribution of petroleum products to end users.

II. THE ELECTRICITY SECTOR.

Electricity is supplied through the electric utility EDL (Electricite du Liban), an autonomous state owned entity under the jurisdiction of the Ministry of Hydraulic and Water Resources (MHWR). The electricity generating plants comprise the following units [4,8]:

- 15 hydro-electric plants having a combined capacity of 281 MW constituting 19% of the total nominal capacity. The Awali plant is the largest of these with 109.5 MW capacity.

- three major thermal plants with combined nominal capacity of about 1300 MW, comprizing Zouk (61% of capacity), Jieh (26%) and Hrayshe (13%).

In 1994, electricity production was evaluated at 5184 GWh [4](taking into account network losses). Because EDL is unable to continuously provide electricity, many domestic, industrial and commercial users have supplemented EDL supplies with their own private generators. The share of electric generation in Lebanon in 1994 was: EDL:66%, Domestic and Commercial: 12% and Industry: 22% [4].

At present, the electricity sector in Lebanon is approaching the end of a major rehabilitation program which resulted in rehabilitating all its physical components, and upgrading its generating capability. EDL will be subjected to an extensive extension program whereby modern technologies, managerial skills and planning techniques will be introduced in order to improve the efficiency and quality of services.

III. THE TRANSPORT SECTOR.

Since 1993 transport functions have been the responsibility of the Ministry of Transport (MoT) [8]. The Directorate General of Civil Aviation and the Directorate General of Land and Marine Transport operate under the MoT. The Railways and Public Transport Authority (RPTA), which is an independent public authority also functions under the supervision of the MoT. The classified road network in

Lebanon is made up of 6295 km of paved roads. This network includes 523 km of international highways, 1640 km of major roads, 1352 km of secondary roads and 2780 km of local roads. The size of the vehicle fleet in Lebanon is estimated at 1.1-1.2 million. The rail system is made up of 428 km but was badly damaged during the war. In 1994 the rail system was not functioning [3].

1.3 ESTIMATIONS OF EMITTED GREENHOUSE GASES USING THE REFERENCE APPROACH

The total amount of liquid secondary fuels that was imported to Lebanon in 1994 is 4107883Tons broken down as shown in Table 1-1:

Table 1-1. Fuel imports by type

Fuel Type	Imports, Tons
Gasoline [3,9,10]	1243182
Jet kerosene [3]	145910
Other kerosene [3]	100
Gas/Diesel oil [3,8,9]	818123
Fuel oil [3,8]	1411014
LPG [5,6]	146000
Bitumen [7]	66000
Lubricants [6,8]	277554

The use of solid fuel and biomass fuel is minor and confined to the use of 160000 Tons of wood [11], 1560 Tons of charcoal [7] and 180000 Tons of coking coal [8]. The lubricants were estimated as follows: 227000 litres are used by EDL and 40% [6,8] of this amount (i.e. 90800 litres) are used by private generators. The conversion factor from litres to Tons is 1.145 [8].

The conversion and carbon emission factors as well as the fraction of carbon oxidised and stored used for all fuel types are those recommended by the IPCC methodology.

Data on international bunkers in Lebanon were restricted on international aviation because the amount of fuel that goes on international marine has never been documented and is believed to be minor [10]. Domestic aviation is almost non existent in Lebanon and therefore all imported jet kerosene goes on international aviation except for 1910 Tons used by few training planes [9].

The actual CO_2 emissions as obtained from the reference approach are shown in Table 1-2.

Table 1-2. Actual CO_2 emissions from various fuels

Fuel Type	Emissions, Gg
Gasoline	3821.036
Jet kerosene	6.028539
Other kerosene	0.318387
Gas/Diesel oil	2599.353
Fuel oil	4343.485
LPG	426.9055
Bitumen	0
Lubricants	404.9235

1.4 ESTIMATIONS OF EMITTED GREENHOUSE GASES USING THE SECTORAL APPROACH

This section reports the greenhouse gases emitted from various sectors, namely, energy industries, manufacturing industries and construction, transport, residential, commercial/institutional, and agriculture/forestry/fishing. The conversion and carbon emission factors as well as the fraction of carbon oxidised and stored used for all fuel types are those recommended by the IPCC methodology.

I. ENERGY INDUSTRIES

In Lebanon, the term energy industries relates only to the electric utility EDL. In this sector, the types of fuel used are gas/diesel oil, fuel oil and lubricants as described by Table 1-3. Also Table 1-3 reports the CO_2 emissions from the energy industry sector.

Table 1-3. Fuel types used by EDL

Fuel Type	Imports, Tons	CO_2 Emissions, Gg
Gas/diesel oil [3,4]	48650	154.5715
Fuel oil [3,4]	1124070	3460.193
Lubricants [8,6]	198.253	289.231

II. MANUFACTURING INDUSTRIES AND CONSTRUCTION

Table 1-4 describes the fuels used by this category as well as the CO_2 emissions.

Table 1-4. Fuel types used by the manufacturing industries and construction

Fuel Type	Imports, Tons	CO_2 Emissions, Gg
Gas/diesel oil [8,3]	425424	1351.6637
Fuel oil [8,3]	286944	883.29187
LPG [3,5]	21060	61.579657
Coking coal [8]	180000	115.6924
Lubricants [8,6]	79301.3	170.69094
Municipal solid waste [12]	1500	4.765823

The gas/diesel oil used in this sector was estimated at 52% of the total fuel imported to the country [8]. The fuel oil is calculated as the total imported minus the EDL consumption. The consumption of LPG by this sector is estimated as follows: The total import of LPG is 146000 Tons [5]. Out of this 65000 Tons are used by households. The remaining amount is 81000 and the LPG for industry is estimated at 26% of this figure. Such an estimate is based on the assumption that the consumption of LPG and electricity are similar. Figures for electricity consumption were taken from [6, 4].

The consumption of coking coal was taken from [8] and the lubricants consumption is, as mentioned in section III , 40% of EDL consumption.

C. TRANSPORT

In this analysis, domestic aviation, road transport, national navigation and international bunkers are reported. The types of fuel used under this category are given in Table 1-5.

Table 1-5. Fuel types used by the transport sector

Fuel Type	Imports, Tons	CO_2 Emissions, Gg
Gasoline (road) [3]	1242.8033	3819.8723
Diesel oil (road) [3]	40906	129.96718
Jet kerosene [3]	1910	6.028539
Gasoline (navigation) [10,13]	0.378612	1.16369
Diesel oil (navigation) [10,13]	0.0292	0.09277

Information on International bunkers is restricted to international aviation. The fuel used by the latter is 144000 Tons and the CO_2 emissions are 454.507 Gg.

The consumption of gas/diesel oil is estimated at:

- Road: 5% of total gas/diesel oil import base on reference [8].
- Navigation: 29.232 Tons based on a field survey covering the Saint George and Riviera Hotels [13].

The consumption of gasoline by national navigation is 378.612 Tons also obtained from the same field survey mentioned above. The consumption of gasoline by road transport is the total minus the amount used by national navigation.

IV. COMMERCIAL/ INSTITUTIONAL SECTOR

Table 1-6 describes the fuels used by this category as well as the CO_2 emissions.

Table 1-6. Fuel types used by the commercial/institutional sector

Fuel Type	Imports, Tons	CO_2 Emissions, Gg
Gas/diesel oil	57677	183.25226
LPG	14580	42.632070

In this table, the consumption of gas/diesel oil is mainly spent on space heating. This is estimated at 7.05% of total gas/diesel oil import based on reference [8,6]. The use of LPG is estimated at 18% of the 81000 Tons described in details in section 1.4.B.

E. RESIDENTIAL

Table 1-7 describes the fuels used by this category as well as the CO_2 emissions.

Table 1-7. Fuel types used by the residential sector

Fuel Type	Quantity used, Tons	CO_2 Emissions, Gg
Kerosene [3]	100	0.318387
Gas/diesel oil	65449	207.9455
LPG	110360	322.6937
Charcoal [7]	1560	5.363438
Wood (solid biomass) [11]	160000	550.0962

In this table, the consumption of gas/diesel oil is mainly spent on space heating. This is estimated at 8% of total gas/diesel oil import base on reference[8,6]. The use of LPG is 65000Tons in addition to 56% of the remaining 81000 Tons described in details in section IV.B. The consumption of wood is based on the assumption that 5% of the 800,000 families use wood at a rate of 4 Tons per year [11]

VI. AGRICULTURE/FORESTRY/FISHING

In this sector, only gas/diesel fuel is used under the stationary category. This accounts for 22% of total gas/diesel oil import based on reference [8]. Table 1-8 describes the fuel consumption as well as the CO_2 emissions.

Table 1-8. Fuel types used by agriculture/forestry/fishing

Fuel Type	Imports, Tons	CO_2 Emissions, Gg
Gas/diesel oil	179987	571.8575

1.5 VERIFICATIONS

Since in this inventory two approaches are followed, there is a need to verify the results in order to be sure that they match. This can be confirmed by comparing the results of the sheets related to reference approach with the results documented in the sheets entitled "Review" where information have been collected from various sectors.

1.6 SUMMARY OF INVENTORY RESULTS

As a summary, tables 1-9 to 1-13 provide information on fuels used and GHG emissions by fuel source, by fuel type, by sector and by non-CO_2 emissions.

Table 1-9. Summary of results by fuel source

FUEL TYPE	CONSUMPTION, TJ	CO_2 , Gg
Gasoline	55694.5536	3821.0358
Jet kerosine	85.1669	6.028539
Kerosene	4.475	0.318387
Gas/diesel oil	35449.03787	2599.33649
Fuel oil	56708.6523	4343.4859
LPG	6907.2602	426.90533
Lubricants	11154.9187	404.9235
Coking coal	5040	116.812
Municipal solid wastes	64.995	4.765823
Charcoal	46.64	5.363438
Wood (Solid Biomass)	4784	550.0962
International Bunkers	6420.96	454.50765

Table 1-10. Summary of results by fuel type

FUEL TYPE	CONSUMPTION, TJ	CO_2 , Gg
Total liquid fuel	166069.25	11606.814
Total solid fuel	5040	116.812
Total biomass	4830.64	555.45963

Table 1-11. Summary of results by sector

SECTOR	CO_2 , Gg
Energy Industries	3903.9966
Manufacturing Industries and Construction	2533.8056
Transport	3957.1245
Commercial/Institutional	225.88433
Residential	530.95774
Agriculture/Forestry/Fishing	571.8575
International Bunkers	454.50765

Figures 1.1 and 1.2 show the percentage contribution of CO_2 emissions by fuel sources and fuel types respectively. Figure 1.3 provides information on percentage contribution of various sectors to CO_2 emissions. The percentage contribution of various sectors to non-CO_2 emissions are shown in Figs. 1.4-1.9.

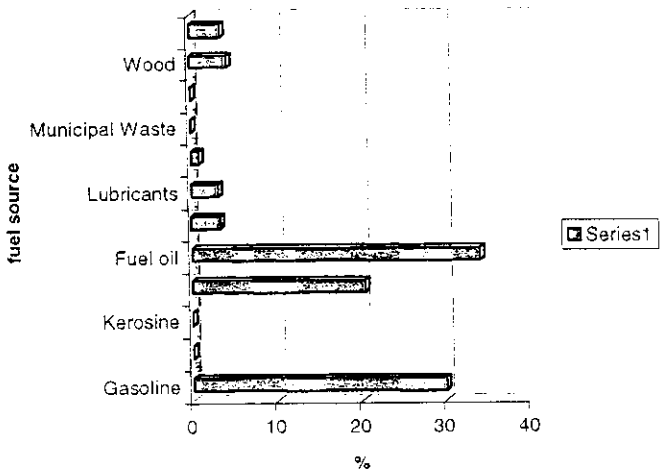

Fig. 1.1 Contribution of fuel sources to CO2 emissions

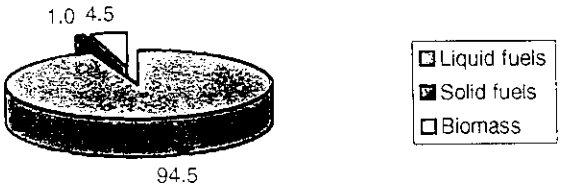

Fig. 1.2 Contribution of fuel types to CO2 emissions

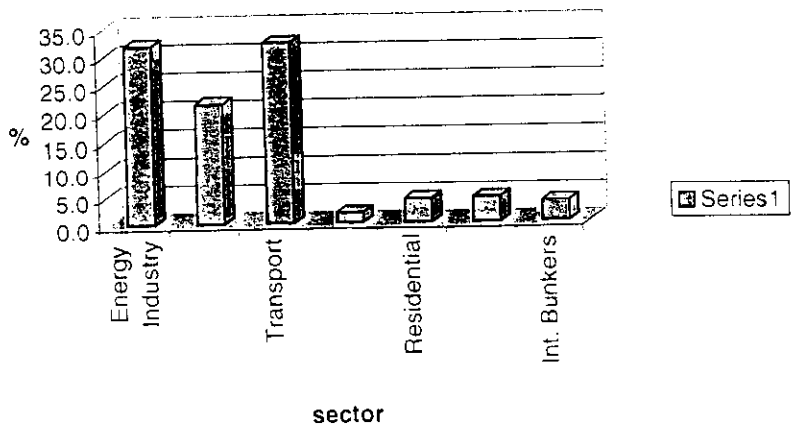

Fig. 1.3 Contribution of various sectors to CO2 emissions.

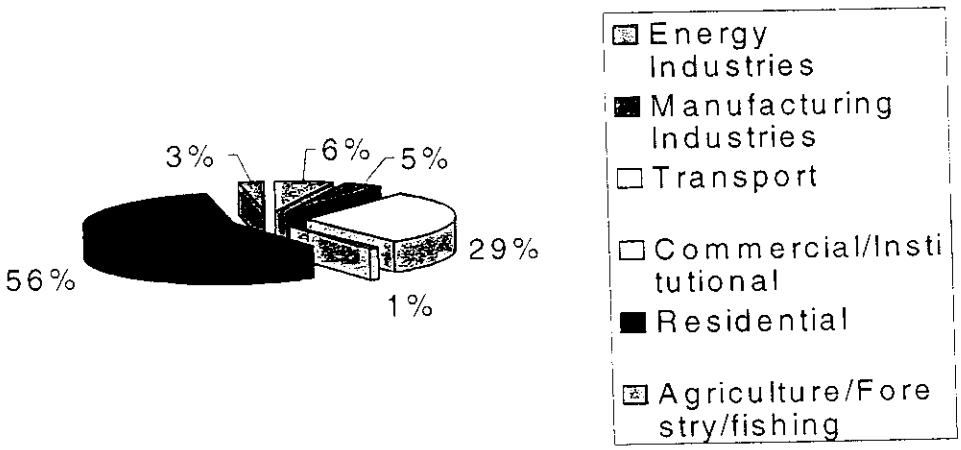

Fig. 1.4 Contribution of various sectors to CH4 emissions.

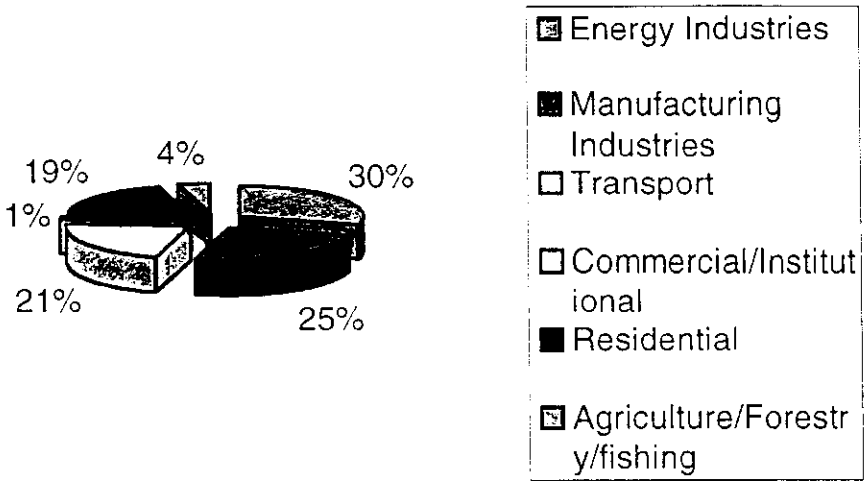

Fig.1.5 Contribution of various sectors to N2O emissions.

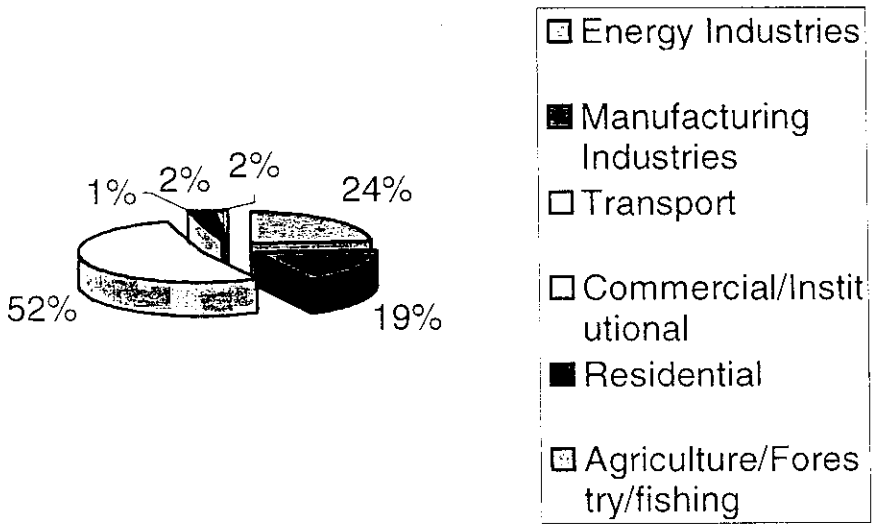

Fig. 1.6 Contribution of various sectors to NOx emissions.

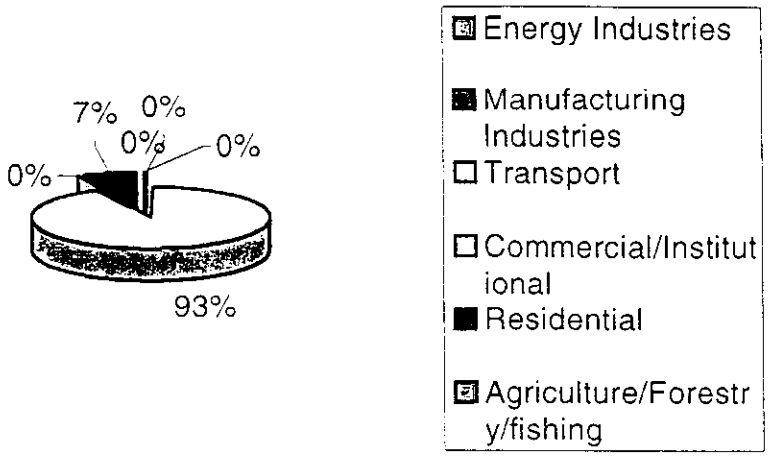

Fig. 1.7 Contribution of various sectors to CO emissions.

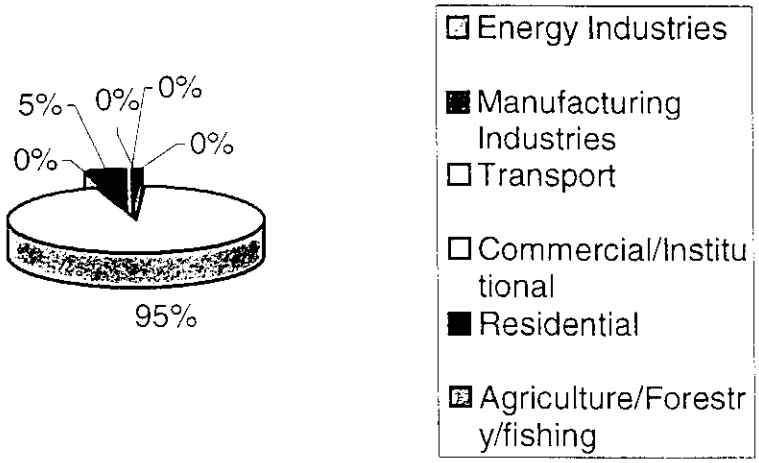

Fig. 1.8 Contribution of various sectors to NMVOC emissions.

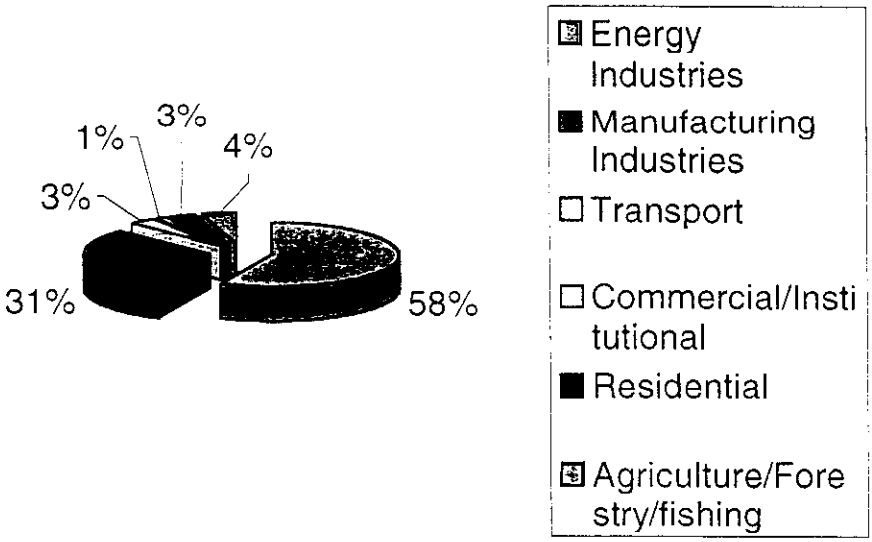

Fig. 1.9 Contribution of various sectors to SO2 emissions.

Table 1-12. Summary of results of non-CO_2 emissions, Gg

SECTOR	CH_4	N_2O	NO_x	CO	NMVOC
Energy Industries	0.169222	0.033844	11.281501	0.846112	0.282037
Manufacturing Industries and Construction	0.121858	0.028493	8.6578949	0.357294	0.279447
Transport					
Road	0.7835	0.024303	24.657609	311.6343	58.45359
Domestic Aviation	4.2583×10^{-5}	0.000170	0.025550	0.008567	0.004258
Domestic Navigation	9.11×10^{-5}	1.094×10^{-5}	0.0273406	0.018227	0.003645
Commercial/Institutional	0.02844	0.001568	0.2844034	0.084471	0.015944
Residential	1.4990	0.021408	1.0281585	24.564344	2.915371
Agriculture/Forestry/ Fishing	0.0779	0.004679	0.7798836	0.1559767	0.038994
Total	1.23567	0.095343	46.26394	337.6692	59.1228
International Bunkers	0.0032105	0.0128419	1.926288	0.642096	0.321048

Table1-13. Summary of results of SO_2 emissions, Tons

SECTOR	SO_2
Energy Industries	45021.676
Manufacturing Industries and Construction	24667.302
Transport	2678.5668
Commercial/Institutional	1130.5846
Residential	2579.0874
Agriculture/Forestry/ Fishing	3528.1052
Total	79605.3
International Bunkers	141.1344

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[2]. The revised 1996 IPCC guidelines for national Green House Gas Inventory. Work book, (Vol. 2).

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[8]. Environmental Resource Management. Final Report on the State of the Environment in Lebanon. Funded by the World Bank. 1993.

[9]. Communication with the Director of Fuel Department, Beirut International Airport.

[10]. Communication with the Directors of Ports of Beirut, Saida, and Tripoli.

[11]. Survey made by Dr. R. Chedid at AUB.

[12]. Communication with Mr. M. SLeiman, CDR.

[[13]. Communication with the Directors of Saint George and Riviera Hotels.

Table 1 Sectoral Report For Energy

Sheet (1 of 2)

Sectoral Report for National Greenhouse Gas Inventories (Gg)							
Green House Gas Source snd Sink Categories	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	SO_2
Total Energy	**11723.6229**	**2.67993391**	**0.10698093**	**46.74144**	**337.56071**	**61.99289**	**79.798562**
A Fuel Combustion Activities (Sectoral Approach)							
1 Energy Industries	3903.996	0.1692	0.0338	11.2815	0.8461	0.282	45.216
a Public Electricity and Heat Production	3903.996	0.1692	0.0338	11.2815	0.8461	0.282	45.216
b Petroleum Refining	0	0	0	0	0	0	0
c Manufacture of Solid Fuels and Other Energy	NO	NO	NO	NO	NO	NO	NO
2 Manufacturing Industries and Construction	2533.805	0.1218	0.02849	8.6578	0.3572	0.2794	24.667
a Iron and Steel							
b Non-Ferrous Metals							
c Chemicals							
d Pulp, Paper, Print							
e Food Processing, Beverages and Tobacco							
f Other(please specify)							
3 Transport							
a Civil Aviation	6.02853	0.00004258	0.00017	0.0255	0.00851	0.00425	0.001872
b Road Transportation	3949.839	0.7835	0.0243	24.657	311.634	58.4535	2.67669
c Railways	0	0	0	0	0	0	0
d Navigation	1.2564	0.00009133	0.00001093	0.02734	0.0182	0.00364	0
e Other(please specify)							
4 Other Sectors							
a Commercial/Institutional	225.884	0.0284	0.00156	0.2844	0.0844	0.0159	1.13
b Residential	530.957	1.499	0.014	1.0281	24.4564	2.9153	2.579
c Agriculture/Forestry/Fishing	571.857	0.0779	0.00465	0.7798	0.1559	0.0389	3.528
5 Other (please specify)							

Table 1 Sectoral Report For Energy

Sheet (2 of 2)

Sectoral Report for National Greenhouse Gas Inventories (Gg)							
Green House Gas Source snd Sink Categories	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	SO_2
B Fugitive Emissions From Fuels	NO	NO	NO	NO	NO	NO	NO
1 Solid Fuels							
a Coal mining							
b Solid Fuel Transformation							
c Other(please specify)							
2 Oil and Natural Gas	NO	NO	NO	NO	NO	NO	NO
a Oil							
b Natural Gas							
c Venting and Flaring							
Memo Items							
nternational Bunkers							
Aviation	454.507	0.00321	0.01284	1.926	0.642	0.321	0.14134
Marine	NE	NE	NE	NE	NE	NE	NE
CO_2 Emissions from Biomass	555.459						

SECTOR 2. INDUSTRIAL PROCESSES INVENTORY

2.1 INTRODUCTION:

Lebanon, in its recovery process from after the war has made efforts to actively participate in international forums related to the environment and the climate. Studies aimed at understanding the causes of environmental problems and their societal impact are now favourably supported by the Government of Lebanon, Universities and non-profit groups. Industrial sector is one of the targeted sectors for survey and assessment study of its environmental implications through waste production and disposal. In 1994, industry in Lebanon accounts for 14% of the total GNP compared to agriculture accounting for 26% and to the service sector accounting for 60%.

This work objective is to conduct a greenhouse gas emission inventory of the industrial processes in Lebanon for the year 1994. Six gases are known to be significant greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), nitrogen oxides (NOx), carbon monoxide (CO) and non-methane volatile organic compounds (NMVOCs). Industrial sources in Lebanon, which contribute to significant emission of these gases, are identified through IPCC guidelines (Intergovernmental Panel on Climate Change) and emission estimates are reported in Standard Tables format. . Sulphur dioxide (SO_2) emission sources and emission estimates are also reported for Lebanon. Other gases that do not occur naturally are the Chlorofluorocarbon and halons, which are used in refrigeration, air-conditioning, foam and solvent production. These gases are already being phased out worldwide.

For 1994 the inventory of the industrial processes uses methodologies taken or from IPCC Reference Manual on Guidelines for National Greenhouse Gas Inventories [1]. The sources of the compiled data have been obtained from official governmental reports or directly from the concerned industries. The inventory has focused on the following relevant industries to greenhouse gas emissions in Lebanon:

- Cement production
- Lime production
- Road paving Asphalt, and roofing Asphalt
- Glass production
- Chemical compounds which includes mainly sulphuric acid, fertilisers and plastics.
- Steel products where raw iron is imported.
- Aluminium shaping and extrusion factories.
- Paper & printing (raw material of dried pulp is imported).

- Food processing which includes processing of local crops for sugar and wine production. It also includes meat and poultry and margarine. For the processes of bread making and coffee roasting, the wheat and green coffee are mainly imported.

The amounts of greenhouse gases released to the atmosphere via the above-specified industrial processes have been estimated using the IPCC methodology and emission factors. Where national emission factors varied from those of IPCC, the factors are discussed.

2.2 THE INVENTORY PROCESS:

The inventory proceeded by identifying the process and emission sources in the Lebanese industry. The Industrial firms surveyed are: the cement production, lime, chemical products, asphalt roofing, paper and printing, cosmetics, foam and plastics, iron and steel, aluminium extrusion and food and drinks. A list of the industrial firms to be surveyed was prepared. Forms were sent to each specific industry requesting information about their production of relevant components of interest and the type and amount of fuel used in the year of 1994 and the following years as available. Data was obtained from several sources for comparison with other industrial census and surveys conducted in Lebanon and reported by the Lebanese Government.

The first part of this sectoral report is concerned with emission estimations for each type of industry emitting greenhouse gases. The verification procedures used to check data are also reported. The completed set of inventory worksheets of IPCC on industrial processes are compiled in Appendix 2.

2.3 ESTIMATIONS OF EMITTED GREENHOUSE GASES FROM VARIOUS INDUSTRIAL PROCESSES IN LEBANON (1994):

A. Cement Production (CO_2 & SO_2 Emissions):

There are two Portland cement plants and one white cement plant in Lebanon. Data was available on the total production of cement in 1994 from the Administration of the Statistical Centre of the Counsel of Ministers [3]. The inspected reported that the fraction of lime in the cement produced in Lebanon is between 0.6 and 0.65. The value of 0.635 is used in our calculations of the emission factor (t CO_2/ t cement produced). This is also the same default value reported in the IPCC guidelines for estimating emission factors of CO_2 from cement, [2].

Work sheets 2-1 of Appendix 2 give the estimated emissions of CO_2 and SO_2 due to cement production in Lebanon in 1994.

B. Lime Production (CO_2 Emissions):

The company that produces lime in Lebanon is the Lebanese Lime & Plaster Factory. Data on lime production has been obtained directly from the Lime Factory for the year of 1994 as given in Table 2-1.

Table 2-1 Lime Production Data in 1994

YEAR	PRODUCTION OF LIME (TONNES)	RAW MATERIAL LIMESTONE (TONNES)	PRODUCTION CAPACITY (TONNES)	ENERGY SOURCE FUEL OIL (LITRE/ TONNE OF LIME PRODUCED)
1994	6,960	1,100	150,000	100

The lime produced in Lebanon uses a kiln-calcite feed which has an emission factor of 0.79 tonnes CO_2 per tonne of quicklime produced [2,pp2.5]. Worksheet 2-2 of Appendix 2 presents the data for CO_2 emissions due to quicklime production in Lebanon in 1994.

A. Soda Ash Use (CO_2 Emissions)

Soda ash is not produced in Lebanon. It is imported and is mainly used in glass production in Lebanon. There are two major glass producers. One is located in Shuwaifat and the other in Shtura. The ratio of soda ash quantity used in tonnes per tonne of glass produced was calculated as 0.169973 based on information provided by the factories. The details of the data are given in Table 2-2.

The container glass production in Shuwaifat factory in 1994 was 32,211 tonnes and the soda ash use was 5,475. The Shtura factory produced 23,819 tons of container glass in 1994 and so the soda ash used is calculated as 4,048.6 tonnes. The flat glass production is 15,000 tonne, which uses 2,549.595 tonnes of soda ash. So the total soda ash use in the year of 1994 is 12,072.6 tonnes.

Worksheet 2-4 of Appendix 2 presents the data for CO_2 emissions due to soda ash production and use in Lebanon in 1994.

Table 2-2 Container Glass Production and Soda Ash Use in 1994

FACTORY NAME	CONTAINER GLASS PRODUCTION (1994) (TONNES)	AMOUNT OF SODA ASH USED (1994) (TONNES)	FUEL USED (1994)		
			Fuel Oil	Diesel	LPG (Tonnes)
MALIBAN Manufacturers of Glass Containers (Chtura)	23,819	--------	5,077 (10^3 Ltrs)	4,001 (10^3 Ltrs)	708.95
Shuwaifat Glass Factory (Shuwaifat)	32,211	5475	6823 (Tonnes)	3481 (Tonnes)	561

D. Production & Use of Miscellaneous Mineral Products:

D.1 Asphalt Roofing Production (NMVOC & CO Emissions)

There is one asphalt-roofing plant in Lebanon (CMC Construction Material Company SAL). The company provides no data. The emissions from asphalt roofing production are estimated from the national total imported mass of the product. The data is obtained by considering the amount of asphalt imported as raw material. It is reported that in 1993, 51,000 tonnes of asphalt are imported, 108,839 tonnes in 1996 and 87,585 tonnes in 1997 [4,5]. The amounts of asphalt used as raw material for road paving is obtained from the Ministry of Public Works given in Table 2-3, for the years of 1994 through to 1996.

Table 2-3 Asphalt Production Data

	ROAD PAVING ASPHALT PRODUCTION	IMPORTED RAW ASPHALT	AMOUNT OF RAW ASPHALT USED IN ROAD PAVING	ASPHALT ROOFING PRODUCTION
Year	(Tonnes)	(Tonnes)	(Tonnes)	(Tonnes)
1994	218,994	51,000	10,586	40,414
1995	209,092	----------	10,598	----------
1996	260508	108,839	12,960	95,879
1997	335885	87,585	16,518	71,067

The amount of roofing asphalt is 40,414 found from the difference between the total amount imported (51,000 tonnes) and the amount used for road paving (10,586). According to IPCC guidelines it is possible to assume that all of the asphalt not used for road paving is blown [2]. The emission factor in kg NMVOC/tonne asphalt roofing produced is taken as 2.4 for a no control blowing process, using table 2-3 of IPCC guidelines [2]. The emission factor for CO is taken for a blowing process as 0.0095 using Table 2-2 of the IPCC guidelines [2].

Worksheets 2-5 (1&2) of Appendix 2 present the data for NMVOC & CO emissions due to asphalt roofing production and use in Lebanon in 1994.

D.2 Road Paving With Asphalt (NMVOC Emissions)

The quantity of road paving material used in Lebanon in 1994 has been obtained from the Ministry of Public Work. The data is shown in Table 4-3. The emission factor of 0.023 kg of NMVOC per tonne of paving material used in the asphalt plant, is obtained from IPCC guide lines reference volume [1]. The emission factor of 320 kg of NMVOC per tonne of paving material used in the road surface, is obtained from the IPCC guide lines reference volume [1].

Worksheets 2-5 (3) of Appendix 2 presents the data for NMVOC emissions due to asphalt road paving in Lebanon in 1994.

D.3 Glass Production (NMVOC Emissions)

The total amount of container glass produced in Lebanon is already reported from the factories and is given in Table 2-2 of this report. The flat glass production amount is obtained using a maximum production capacity of 1.86 Million m^2/year of flat-glass, [5]. This is converted to tonnes using an average glass thickness of 5mm and an average density of 2700 kg/m^3 ,so that the estimated glass production in tonnes = 1.86 x thickness 0.005* density*1000. Assuming that the flat glass production is at 60% of its maximum value, then a final value is obtained for glass production in tonnes in 1994. The emission factor of 4.5 is obtained from the Revised 1996 IPCC guidelines [1].

Worksheet 2-5(4) of Appendix 2 presents the data for NMVOC emissions based on total amount of glass produced in Lebanon in 1994.

E. Production of Chemicals

E.1 Production of Sulphuric Acid (SO_2 Emissions)

The only chemical produced in Lebanon that contributes to greenhouse gas emission is the sulphuric acid. The amount of sulphuric acid produced in Lebanon is reported to be 135000 tonnes per year [6]. It was extremely difficult to get data directly from a list of 5 major chemical producing companies. The companies do not disclose such information so as not to be liable for pollution.

Work sheet 2-10 (5) presents the data for SO_2 emissions based on the total quantity of sulphuric acid produced in Lebanon in 1994.

F. Iron & Steel Production (CO_2, NO_x, NMVOC, CO& SO_2 Emissions)

The total production capacity of steel mills in Lebanon is 480,000 tonne [5]. The total amount of the raw iron imported to Lebanon is 273,965 tonnes in 1994, [3]. It is assumed that all the imported raw material is used by the factories and is corrected by a factor of 1.015 to account for the added carbon in the steel processing using rolling mills. The emission factors used for green house gas production per tonne of steel produced are obtained from tables 2-13 to 2-16 in the 1996 IPCC Guide Lines, [2].

Work sheets 2-11 (2&3) of Appendix 2 present the data for CO_2 , NO_x, CO, NMVOC and SO_2 emissions based on the total quantity of steel produced in Lebanon in 1994.

G. Pulp & Paper Industries:

Paper industry is one of the major industries in Lebanon. It does not involve the production of dried pulp. The Pulp is imported from other countries.

H. Food & Drink (NMVOC Emissions):

H.1 Alcoholic Beverages:

Wine and Beer are produced in Lebanon. Data has been obtained directly from the factories for the year 1994 and is shown in Table 2-4. Emission factors in kg NMVOC/ per hl beverage produced are obtained from table 2-25 in the 1996 IPCC GuideLines, [2]. Worksheet 2-13 (1) of Appendix 2 presents the data for NMVOC emissions based on the total quantity of alcoholic beverages produced in Lebanon in 1994.

Table 2-4 Alcoholic Beverages Production in 1994

NAME	QUANTITY OF WINE PRODUCED (1994) (LTRS/YEAR)	QUANTITY OF BEAR PRODUCED (1994) (LTRS/YEAR)
Chatou (Beirut)	941,770	111,215
Ksara (Beirut)	1,100,000	750,000
Total	2,041,770	861,215

H.2 Bread and Other Food Products:

Emission factors in kg NMVOC/ per tonne of food produced are obtained from table 2-26 in the 1996 IPCC Guide Lines, [2]. The main food processing industries in Lebanon include meat and poultry, margarine, Biscuits and cakes, bread and coffee roasting.

Meat and Poultry production is obtained from the Arab Union of Food Industry Report, page 21, [7]. The production in 1991, 1992, and 1993 was 79,000, 80,000 and 80,000 tonnes respectively. It is also assumed to be the production of the year 1994.

Sugar production is obtained from two references, one is from the Arab Union of Food Industry Report,[7] and from the Trade Information Centre, Ministry of Economy and Trade.

Margarine production is production is obtained from the Arab Union of Food Industry Report, pages 14 & 48 in Tables 7 and 17 of Reference 7. The total production of olive oil in 1994 was 8000 tonnes subtracted from the total production of margarine and oil which was 29,590 tonnes. This will give margarine production of Lebanon in 1994 as 21,590 tonnes.

Biscuits, cakes and bread are produced from wheat. The total amount of wheat imported and produced in Lebanon is 389,000 tonne. Seventy five percent will be used for bread production and 25% will be used for cakes and biscuits. The amount of wheat used for bread making is multiplied by a factor of 1.2 based on the fact that each kg of wheat produces 1.2 kg of bread.

The amount of green coffee imported to Lebanon in 1994 is obtained from Reference 7, page 34.

The emissions of NMVOC are presented in worksheet 2-13 (2) of Appendix 2 based on the total quantities of various types of food produced in Lebanon in 1994.

I. Emissions Related to Production of Halocarbons and Sulphur Hexafluoride:

Lebanon imports all its needs of HFC's and PFC's for use in the refrigeration, air conditioning applications, in the aerosol, solvents and foam industry, and in the fire fighting sector. Those sectors are using the Ozone Depleting Substances. Lebanon has only recently ratified the Montreal Protocol on March 31, 1993. Since then Lebanon has been working in a country program for applying phase out measures on these substances. In 1994, the phase out process was not yet enforced. The ban on imports and use of the Ozone Depleting Substances started only in 1996. A chemical substitutes of these substances such as HFC134a was imported in small amount (2 tons) to Lebanon in 1993, [8]. It is assumed that in 1994, also an equal quantity is imported. The quantities imported of HFC's is expected to increase substantially in the following years after the ratification of the Montreal Protocol (1993) and they have to be included in any future inventory. In this report only the bulk potential halocarbon emissions is calculated based on the amount imported [1,2]. This is summarised in Worksheets 2-15 (1-3) of Appendix 2.

2.4 SUMMARY OF THE INDUSTRIAL PROCESSES INVENTORY:

In 1994, Lebanese Industry has emitted 1951.841 Gg (1,951,841 Tonnes) of carbon dioxide, 0.361884 Gg (361884 Tonnes) of carbon monoxide, 0.01112 Gg of nitrogen oxide, 70.5114 Gg (70,511.4 Tonnes) of non-methane volatile organic compounds and 3.5346 Gg (3534.6 Tonnes) of sulphur dioxide.

The cement industry is the major source for CO_2 emissions from the industrial processes in Lebanon. Cement industry is responsible for 76.1% of the total emissions of the industrial processes followed by the iron and steel industry which produces 22.8% of the total CO2 emissions from industrial processes. Figure 2-1 shows the percentage distribution of various industrial sources contributions to CO_2 emissions in Lebanon.

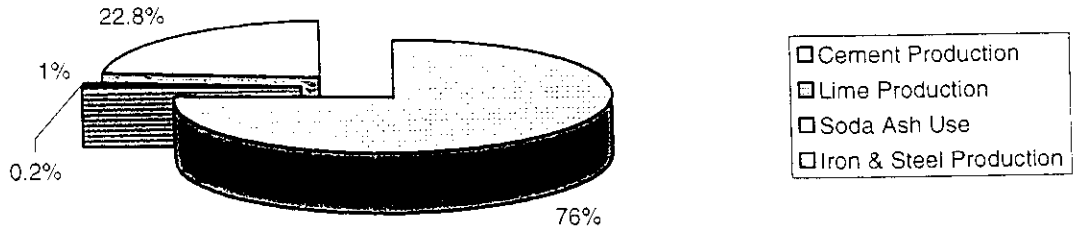

Fig. 2-1 CO_2 Emissions from Industrial Sources

The NMVOC emissions are mainly produced by the use of asphalt for road paving (95% of total emissions by industry) followed by the food and drink industry (4.88%). Chart 2 shows the percentage distribution of various industrial sources contributions to NMVOC emissions in Lebanon.

The emissions of sulphur dioxide SO2 come from three industrial sources. The first source is from the production of sulphuric acid (66.8% of total industrial emissions). The second is the cement industry (25.3% of total industrial emissions) and the third is from the iron and steel mills (7.9% of total industrial emissions). Chart 3 shows the percentage distribution of various industrial sources contributions to SO_2 emissions in Lebanon.

Carbon monoxide emissions in the industrial sector are very small. The major source is iron and steel mills and the other minor source is asphalt-roofing production.

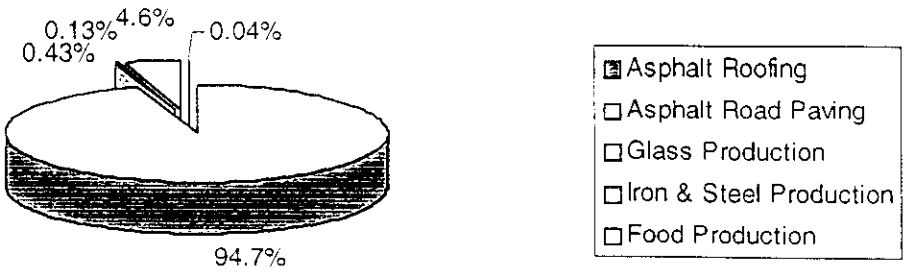

Fig. 2-2 NMVOC Emissions from Industrial Sources

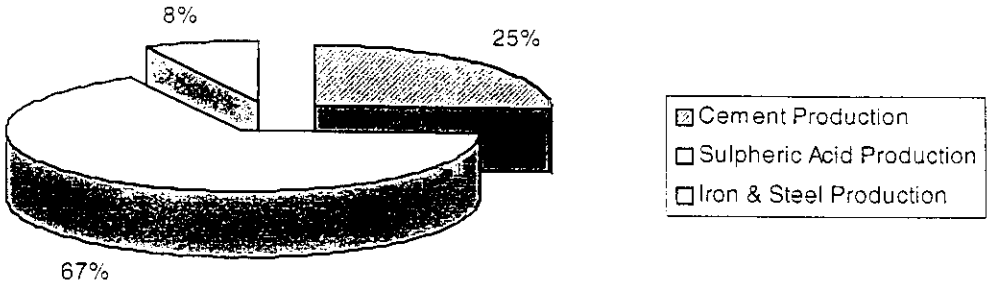

Fig. 2-3 SO_2 Emissions from Industrial Sources

Uncertainties and limitations are associated with the estimated greenhouse gas emissions. The emissions reported for industrial processes in Lebanon reflect current best estimates. Thus the reported emissions inventory provides a foundation for the development of a more detailed and comprehensive Lebanese inventory in the future. Specific limitations include: a) Quantitative estimates for some sources of greenhouse gas emissions were not always based on data obtained from specific sources, but from bulk imports of certain products; and (b) the accuracy of the inventory estimates relies heavily on emissions factors available from the IPCC Guidelines [1,2]. These factors are used in the Lebanese inventory. These factors may differ for some local industrial processes because of differences in the raw material used.

2.5 REFERENCES:

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2. The Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Workbook (Volume 2).

3. Republique Lebanaise, Presidence Du Council De Ministers, Administration Centrale de la Statistique, "Bulletin Statistique", No. 95/4, pp. 15, 1995.

4. A. Hajj, "The oil bill", Saphir News paper, issue of Feb.2, 1998, pp.9. Tables 1 & 2 obtained from the Ministry of Oil.

5. Environmental Resource Management Report on the state of the environment in Lebanon. Funded by the World Bank and conducted by the EDL, pp. 112, table 7.3b, 1993.

6. Ministry of Environment Study report, Lebanon, Feb.13-15, 1996.

7. F. Jabr, "Lebanese Food Industries Report" Arab Union for Food Industries. Report Submitted to the Ministry of Industry, 1993-1994.

8. Ministry of Environment, Report of the Country Program of the National Working Committee on Ozone Depleting Substances in Lebanon, March 1996.

Table 2 Sectoral Report For Industrial Processes

Sheat (1 of 2)

Sectoral Report for National Greenhouse Gas Inventories (Gg)													
een House Gas Source snd Sink Categories	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	SO_2	HFCs		PFCs		SF_6	
								P	A	P	A	P	A
Total Industrial Processes	**1951.80**			**0.01**	**0.36**	**70.511**	**6.977**	**0.02**		**0.00**		**0.00**	
A Mineral Products													
1 Cement Production	1485.50						0.894						
2 Lime Production	16.41												
3 Limestone and Dolomite use	0												
4 Soda Ash Production and Use	5.01												
5 Asphalt Roofing					0	0.097							
6 Road Paving						70.067							
7 Others (Glass Production)						0.320							
B Chemical Industry													
1 Ammonia Production	0				0	0	0						
2 Nitric Acid Production	0												
3 Adipic Acid Production	0												
4 Carbide Production	0												
5 Others (Sulpheric Acid)							2.3625						
C Metal Production													
1 Iron and Steel Production	444.92			0.0111	0.3615	0.0278	0.2781						
2 Ferroalloys Production	0			0	0		0						
3 Aluminum Production	0			0	0		0						
4 SF6 Used in Aluminum And Magnesium Foundries	0												
5 Others (please specify)	0												

Table 2 Sectorial Report For Industrial Processes

Sheat (2 of 2)

Sectorial Report for National Greenhouse Gas Inventories (Gg)													
een House Gas Source snd Sink Categories	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	SO_2	HFCs		PFCs		SF_6	
								P	A	P	A	P	A
D Other Production													
1 Pulp and Paper	NO	NO	NO	NO	NO	NO	NO						
2 Food and Drink						3.4428							
E Production of Halocarbons and Sulphur Hexafluoride								NO	NO	NO	NO	NO	NO
1 By-Product Emissions								NO	NO	NO	NO	NO	NO
2 Fugitive Emissions								NO	NO	NO	NO	NO	NO
3 Other (specify)								0.002	NE	0	NE	0	NE
F Consumption of Halocarbons and Sulphur Hexafluoride									NE		NE		NE
1 Refrigeration and Air Conditioning Equipment									NE		NE		NE
2 Foam Blowing									NE		NE		NE
3 Fire Extinguishers									NE		NE		NE
4 Aerosols									NE		NE		NE
5 Solvents													
6 Other (specify)													
G Other (please specify)													

P: Potential emissions based on Tier I Approach. A= Actual emissions based on Tier 2 Approach

SECTOR 3. SOLVENT AND OTHER PRODUCT USE

This category covers mainly NMVOC emissions resulting from the use of solvents and other products containing volatile compounds. It also includes CO_2 and N_2O emissions from anaesthetic and propellant gases. The only relevant part to Lebanon in this sector is the paint applications, degreasing and dry cleaning. In Lebanon the amount of paint used in 1994 is estimated as 669 tonnes, while the amount of degreasing and dry cleaning solvents is estimated as 2,706 tonnes in 1994, [1]. The IPCC 1996 guidelines for national greenhouse gas inventories [2], does not provide emission factors of the amount of greenhouse gas per tonne of solvent which is necessary to calculate the emitted amounts of gases.

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2. The Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Reference Manual (Volume 3).

Table 3 Sectoral Report For Solvent and Other Product Use

Sectoral Report for National Greenhouse Gas Inventories (Gg)			
Green House Gas Source snd Sink Categories	CO_2	N_2O	NMVOC
Total Solvent and Other Product Use			NE
A Paint Application (Sectoral Approach)			NE
B Degreasing and Dry Cleaning			NE
C Chemical Products, Manufacture and Processing	NO	NO	NO
D Other (Please Specify)	NO	NO	NO

SECTOR 4. AGRICULTURE

4.1 INTRODUCTION

The Lebanese topography is such that only about one- third of land area is arable , and cultivation is confined to around 22 % [1]. The agricultural sector employed about 11% [1] of the active population and contributes only an estimated 10 %[1] of national income .

A. CROPS

The Bekaa valley is the dominant agricultural region and therefore the center of a wide range of crops mainly potatoes, tomatoes and sugar beet . South Lebanon is the region of wheat growing while the coastal zone from the north to the south is a support of an intensive agriculture, Primarily citrus , bananas and vegetables. Cereals are largely produced in the north of Lebanon especially in Akkar .

B. LIVESTOCK

Livestock is particularly concentrated in the mountains and in the Bekaa area . Livestock production contributes only an estimated 15% [1] of the domestic market . Cattle and dairy farming are of minor importance ; bovines of all kinds are vastly outnumbered by sheep and goats . Poultry farming is in increasing development. In summary , Lebanon has become a large -scale exporter of fruits , vegetables and poultry , but remains a net importer of animals , dairy products , cereals and poultry feedstuff.

4.2 DOMESTIC LIVESTOCK

This section deals with methane and nitrous oxide emission from two sources:

- Enteric fermentation
- Manure management

Enteric fermentation contributes to methane emission as a by - product of the digestive process.
Manure management . leads , under different conditions, to the emission of methane and nitrous oxide .
For estimation purposes, the revised default methodology developed by the IPCC [2] was followed .
The data needed to estimate methane and nitrous oxide emissions are provided from the FAO production year-book -1994[3]. The table 4 -1 summarizes these data .

Table 4-1 Livestock population

Livestock type	Number of animals (1000_s)			
	1992	1993	1994	average
Cattle	73	77	80	76,7
Dairy Cattle	45	47		46,0
Non-dairy Cattle	28	30		30,7
Sheep	240	250	258	249,3
Goats	465	450	456	457,0
Camels	1	1	1	1,0
Horses	11	12	13	12,0
Mules and Asses	30	31	33	31,3
Swine	42	40	41	41,0
Poultry	20000	24000	24000	22700,0

In the last column of table 4-1 each number is a three year average except that of dairy cattle which is a two year average . The number of non-dairy cattle is obtained by subtracting the two year average of the dairy cattle from the average of the tolal number of cattle .

A. METHANE EMISSION FROM DOMESTIC LIVESTOCK

To estimate the emission of methane from domestic livestock emission factors are needed . These factors are not available , therefore default values of the emission factors presented in the IPCC- Reference Manual [2] for enteric fermentation and manure management are used

B. NITROUS OXIDE EMISSIONS FROM DOMESTIC LIVESTOCK

-The default value (18%) presented in the IPCC- workbook [4], in the used fuel system for dairy and non-dairy cattle is not appropriate for Lebanon
-The default value (77%) presented in the IPCC- workbook [4] , in Pasture Range and Paddock system for dairy and non- dairy cattle seems to be high for the Lebanese cattle farming .

This can be justified by considering the following :

- Personal field survey and interviews with farmers showed that animal waste , since not short time , is not used as fuel in the Hariri farm for cattles and poultry , where there are about 1000 cattles and 4 millions poultry, the supervisor [5] of the farm confirmed the following :

1- Animal waste is not used as fuel . This confirmation belongs not only to the big farms but also to the small farmers
2- Animal waste is stored in form of dry lots in a small area
3- Successively half of the cattles go daily to pasture

- A greet number of cattles stay near the farmhouses and therefore the animal waste is treated in drylot system

- Information from the president of the south farmers congregation [6] indicate the following:
  1- Animal waste burning as fuel is not more a Lebanese farmers practice .
  2- In the farms animal waste is managed in solid storage and drylot system

- There are no natural pastures in Lebanon except for some farms where we found a small area used as pasture [5,6]

From this we can conclude that , for Lebanon, the default value 77% [4] for cattles in pasture range and paddock system is high and that the default values 3 and zero presented in solid storage and drylot system [4] for dairy and non-dairy cattles respectively are very low. Instead of these default values we estimate the following values:

-50% of animal waste for dairy and non-dairy cattle are deposited in pasture range and paddock system. This value is used in the worksheet 4-1 (supplemental) Pasture Range and Paddock.

-48% of animal waste for dairy cattle and 46% for non-dairy cattle are managed in solid storage and drylot system these two values are used in the worksheet 4-1 (supplemental) solid storage and drylot

-0% of animal waste is used as fuel . This value is used in the worksheet 4-1 (supplemental) used fuel

4.3 FIELD BURNING OF AGRICULTURAL RESIDUES

Important quantities of residues are produced from agricultural crops . Several broad categories of crop residues can be distinguished :

- Cereal residues like wheat straw and maize stalks
- Residues from pulse
- Residues from tuber and root
- Residues from legumes

Burning of crop residues in the fields can lead to the emission of the following gases: CO_2 , CO , CH_4 , N_2O and NO_x .

This section accounts for emission of the non- CO_2 gases. The data required for the estimation of the emission of the above mentioned gases from crop residues are provided from FAO production yearbook [3] - 1994 . These data are presented in table 4-2.

Table 4-2 Annual production of crops from which some residues are burned

Crop	Annual production (Gg crop)			
	1992	1993	1994	Average
Wheat	62	50	39	50,333
Barley	21	20	22	21,000
Oats	1	1	1	1,000

We have selected only these crops for the following reasons:

Field survey [7] in Bekaa, information from the south farmers congregation [6] and interviews with experts [8] showed that in Bekaa , south-Lebanon and Akkar , the most important centers of crops , large quantities of crop residues provide an important source of animal feed and at least are collected for this purpose by farmers and stored for the animals.

The fraction of residues remaining in fields after harvest is also used as feed in the case of some cereals like wheat, Barley and oats . Sometimes it is partly burned because of agricultural diseases [8] .

The residues of all other crops are collected and thrown as waste or left on fields. From this we can conclude that field burning of agricultural residues is not a common practice in Lebanon therefore the fraction burned in fields is estimated to be 1%. This value is used in the worksheet 4-4 sheet 1 of 3 step 3. In work sheet 4-4 sheet 1 of 3 the residue to crop ratio used for oat is 1.3, the same as for wheat, because of similarity of oat to the wheat .

4.4 AGRICULTURAL SOIL

Agricultural soils emit N_2O from three sources :

- direct emission from agricultural soils which results from the nitrification and denitrification processes .This is particularly observed in organic soils .
- direct soil emissions from animal waste management systems . This type of N_2O emission results from dung and urine deposited by free-range grazing animals.
- indirect N_2O emission from nitrogen used in agriculture and resulting from the use of fertiliser .

In order to estimate N_2O emission from agricultural soils , the following data are needed :

- Synthetic nitrogen fertilizer consumption. This is available from FAO fertilizer year book [9] - 1996 . These data are presented in table 4-3

- Crop production which is available from FAO production yearbook [3] -1994 . Table 4-4 summarizes these data

- Livestock population in table 4-1 section 4-2

Table 4-3 Annual consumption of N- fertilizer

	1992	1993	1994	average
animal consumption of N- fertiliser tonne - N/yr	12400	14200	18000	14866,6

Table 4-4 Annual production of crops

Crop	annual crop production 1000t/yr			
	1992	1993	1994	average
Cereals [a]	116	103	96	104,9
Pulses [b]	62,1	64,0	67,5	64,5
Tubers and Roots [c]	512	519	555	528,6
Other [d]	715	724	773	737,3

a)- includes : wheat, coarse grain , barley , maize oats and sorghum
b)- includes : dry beans. broad beans, peas, chick peas , lentils , green beans and green peas .
The FAO data of green beans and green peas are multiplied by (1-0,15) to account for crop water content .
(c)- includes : Potatoes, sugar beet and carrots
(d)- includes : Taro , groundnut, cottonseed ,cabage , artichok , cauliflower , Tomatoes , pumpkin , cucumbers onion garlic , watermelon , cantaloupe sugar cane and tobacco leaves.

A. In the worksheet 4-5 A (supplemental) sheet 1 of 1 :
Faw is calculated by considering $Frac_{GRAZ}$ = 0,6 . This value is obtained from the following :

$$Frac_{GRAZ} = \frac{Nex_{GRAZ}}{Nex}$$

$$Frac_{GRAZ} = \frac{25421,1 \times 10^3}{42106,7 \times 10^3} = 0,6$$

F_{CR} is calculated by considering $Frac_{BURN} = \frac{\text{fraction burned in fields for all crops}}{crop_{BF} + crop_{0}}$

$$Frac_{BURN} = \frac{0,717\ Gg}{(64,5 + 1370,8)\ Gg} = 5 \times 10^{-4}$$

II. In the worksheet 4-5 sheet 2 of 5:

The value of Fos is estimated to be null. Information from experts [10] confirmed that there is no organic soil in Lebanon.

F_{aw} = manure nitrogen used as fertilizer in country , corrected for NH_3 and NO_x emissions and excluding manure produced during grazing (kg N/yr)

$Frac_{GRAZ}$ = fraction of livestock nitrogen excreted and deposited onto soil during grazing (kg N / kg N excreted)

Nex_{GRAZ} = nitrogen excretion during grazing (worksheet 4-1) (supplemental) , Pasture Range and Paddock system (kg N / yr)

Nex = total nitrogen excretion by animals in country (kg N/yr)
$Frac_{BURN}$ = fraction of crop residue that is burned rather than left on field

4.5 REFERENCES

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7. Nasser chreif , Plant - expert , yammouneh - Lebanon

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Khald Zahraman , Researcher in the NCSR , Beirut - Lebanon
Samih Hajj , Professor at the Lebanese University , Faculty of Agronomy , Beirut - Lebanon

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10. Talal Darwich , Researcher in the NCSR , Beirut - Lebanon
Samih Hajj [8]

Table 4 Sectoral Report For Agriculture

(Sheet 1 of 2)

Sectoral Report for National Greenhouse Gas Inventories (Gg)					
Green House Gas Source snd Sink Categories	CH_4	N_2O	NO_X	CO	NMVOC
Total Agriculture	**7.97862**	**3.01482**	**0.00146**	**0.04306**	
A Enteric Fermentation					
1 Cattle	2.63840				
2 Buffalo	0				
3 Sheep	1.24650				
4 Goats	2.28500				
5 Camels and Lamas	0.04600				
6 Horses	0.21600				
7 Mules and Asses	0.31300				
8 Swine	0.41000				
9 Poultry	NE				
10 Other (please specify)					
B Manure Management					
1 Cattle	0.12270				
2 Buffalo	0				
3 Sheep	0.03990				
4 Goats	0.07770				
5 Camels and Lamas	0.00192				
6 Horses	0.01968				
7 Mules and Asses	0.02817				
8 Swine	0.12300				
9 Poultry	0.40860				

Table 4 Sectoral Report For Agriculture

(Sheet 2 of 2)

Sectoral Report for National Greenhouse Gas Inventories (Gg)					
Green House Gas Source snd Sink Categories	CH_4	N_2O	NO_X	CO	NMVOC
B Manure Management (cont...)					
10 Anaerobic		0			
11 Liquid Systems		0.00054			
12 Solid Storage and Dry Lot		0.38870			
13 Other (please specify)		0.03020			
C Rice Cultivation		0			
1 Irrigated					
2 Rainfed					
3 Deep Water					
4 Other (please specify)					
D Agricultural Soils		2.59534			
E Prescribed Burning of Savannas		0			
F Field Burning of Agricultural Residues					
1 Cereals	0.00205	0.00004	0.00146	0.04306	
2 Pulse					
3 Tuber and Root					
4 Sugar Cane					
5 Other (please specify)					
G Other (please specify)					

SECTOR 5. LAND-USE CHANGE & FORESTRY

5.1 INTRODUCTION

Forests in Lebanon are considered as important natural resources and contain a remarkable range of vegetation. This is most likely due to geographical, geological and climatic factors. The area covered by the forests is relatively low and constitutes around 7% of the total area of Lebanon.

Most of the basic knowledge about the forest cover of Lebanon originates from the FAO mapping of the Lebanese forests in 1966.

There are various forests with different tree species in Lebanon such as, the "God's Cedars" of Bsharre (North Lebanon), Barouk forest (Mount Lebanon), and Qammouaa forest (North Lebanon). The main forest types widespread in Lebanon are Oak (Quercus calliprinos , Quercus infectoria), Juniper (Juniperus excelsa), Cedar(Cedrus libani), Fir (Abies cilicica), Pines (Pinus pinea, Pinus halepensis, Pinus brutia) and Cypress. The bulk of the forest area consists of Oak and Pine stands and the most climatically favored zone in Lebanon is the western slope of Mount Lebanon. In addition, the Lebanese forests contain diversified species of aromatic, wild, and medicinal plants.

Forests were severely neglected, along with other natural resources during the period of the Lebanese civil war. Therefore, the woodland area of Lebanon has sharply decreased. Deforestation was and still is basically due to the following factors; urban expansion in the mountain areas, illegal trees cutting, unlawful grazing and overgrazing, forest fires and poor management and harvesting policies of the forests. Deforestation has weakened the soil structure, accelerated soil erosion and led to the general degradation of soil quality.

The Barouk Cedar Forest and Horch Ehden (North Lebanon) were designated protected areas by law respectively in 1991 and 1992. The forest law issued in 1949 and still valid, defines the rules of exploitation of the forest, while a recent law introduced in 1996, addresses the issue of forest protection. Currently, a law is under preparation at the MoAg, dealing with the prevision, the prevention and the protection of forest from fire. But Lebanon still suffers from improper enforcement measures against natural and man made forest fires.

The Forestry and Natural Resources Service of the MoAg is the main body in charge of the management of the forestry in Lebanon, with the support of various agencies acting under the jurisdiction of the MoAg. Efforts are now underway to restore and protect the forest cover. Several programs on reforestation and afforestation were implemented by the MoAg and several NGOs. The MoE is currently implementing a UNDP-funded GEF project on Protected Areas (started in 1996).This includes the management and conservation of two cedar's forest areas, in" Barouk" (Central Mount Lebanon) and "Ehden" (North Lebanon). The EU is financing a project on "Protection of the Vegetal Cover in Lebanon, Mainly

Forest Cover". This project, which started in 1997, is executed by the ONF France, and is expected to be achieved in 1999.

5.2 Changes in Forest and Other Woody Biomass Stocks

A. Introduction

The woody biomass stocks in Lebanon are made up of:

1- forest trees;
2- non-forest trees, which include:
   a- farm and village trees (mainly fruit and olive trees)
   b- urban trees.

An overview of the Lebanese forestry has been mentioned in the above section.

The fruit crops grown in Lebanon include both the temperate zone fruits and the subtropical fruits. Citrus, olives, apples, grapes (not considered as farm or village tree) and stone fruits are the main fruit crops, constituting about 90% of the fruit production area and accounting for 80% of the total Lebanese fruit production. Citrus trees are mainly grown in the South and the North of the coastal plain. Olive trees are mostly spread in the medium elevation mountains and are almost entirely rainfed. Bananas are essentially grown in the South coastal area and more recently in greenhouses using tissue cultured plants. 75% of apples are grown in the medium and high elevation mountains. The total fruit production has increased during the last decades by about three folds to reach 1.5 millions tons in 1994 [1].

Although cutting trees is forbidden by law in Lebanon, some commercial harvest for timber production (charcoal and industrial wood) may occur on a limited scale, but data on this illegal practice are not available. Concerning the data on wood removed from forest clearing, extensive investigation has been made with no results both as the governmental and non-governmental institutions. The loss of woodland area in this submodule includes only the fuelwood consumed. The fuelwood energy considered as a traditional one represent with the hydropower energy only 1.7% of total energy consumed in Lebanon and it mainly occurs in some mountain villages for heating in the winter season [2]. The loss of woody Biomass stocks by natural and man made woodland fires has been taken into account on the submodule of forest and grassland conversion.

B. Biomass increment

B.1. Forest area

Primarily it must be pointed out, that the data related to the forests in Lebanon is more uncertain than in any other field. No comprehensive study of the forest has been conducted during the last decade.
The only available data on national level are the following:

1- Coniferous forest area:29250,2 ha (around 40% of the total forest area)
broadleaf forest area: 43215,2 ha (around 60% of the total forest area)
Total forest area: 72465ha [3]. These data could be considered for 1987 since the most recent of the used satellite images date back to the summer of that year.

2- Rough estimates on type forest/species for 1994 [4], **(Table 5.1)**

Table 5.1 Rough estimates on Forest Cover

Type of forest/species	Area (ha)[1]
Oak	38 000
Pinus Pinea	14 000
Pinus Halpensis & Pinus Brutia	10 000
Juniper	9 000
Cedar	2 500
Cypress	2 000
Fir	1 500
Ripisylve	1 000
Total	**78 000**

The Table 5.1 estimates on forest types have been broken down into two subdivisions according to criteria provided by experts:

1- evergreen forest and deciduous forest.

The oak in Lebanon is mainly made up of an evergreen specie, the quercus calliprinosy (around three quarter of the oak area or 28500ha), and a deciduous specie, the quercus infectoria (around the quarter of the oak area or 9500 ha). In addition, all the ripisylve (around 1000 ha) are deciduous, while all the other types are evergreen (around 39000 ha) [5,6].

Therefore the **deciduous forest area is estimated at 10500 ha around 13.5% of the total forest area) and the evergreen forest area at 67500 ha (around 86.5% of the total forest area).**

2- coniferous forest and broadleaf forest.

The oak and the ripisylve are broaleaf forest (around 39000 ha), while all the other type are coniferous forest (around 39000 ha) [6]. Therefore, around **50% of the total forest area is made up of broadleaf forest and 50% of coniferous.**

The first subdivision (deciduous and evergreen) has been adopted in this module since the default values of annual growth rate of dry matter necessary to compute the increment of biomass are available for this subdivision only. Nevertheless, the second subdivision, the same as in the FAO source, (coniferous and broadleaf) have been selected later in the forest and grassland conversion submodule since the default values of dry matter in aboveground

biomass necessary to compute the quantity of biomass burned are available only for this subdivision.

Although, the data of the two sources were collected in two different years (1987 and 1994) and by two different methodologies (one by satellite images processing, and the other by a field work), and since the data of Mr. Akl is a rough estimation, the average of these two data (**75000 ha**) has been used. The estimate of the total forest area constitutes around 7% of the total area of Lebanon.

Therefore, the following figures are used in the worksheet **5-1 (sheet 1 of 3)** to compute the total carbon uptake increment by forest:
Evergreen forest area: 65000 ha (86.5% of 75000 ha the estimated total forest area)
Deciduous forest area: 10 000 ha (13.5% of 75 000 ha the estimated total forest area)

B.2. Non-Forest trees
B.2.1. Farm and Village Trees

The farm and village trees are made up as mentioned before in section 5.2.A of fruit and olive trees. The data available are the areas of fruit and olive trees for 1993 [7] and for 1996 [8].

For baseline year 1994, the area data were estimated as follow:

i- dividing fruit and olive trees into evergreen trees and deciduous trees.
ii- calculation of the difference (increase or decrease) between the 1996 and 1993 data, occurring during three years
iii- division of this difference by three, assuming that the results reflects the difference for one year
iv - application of the difference (increase or decrease) calculated in step (*iii*) on 1993 data. **(Table 5.2)**
Finally, the number of trees for each specie was computed from 1994 data using estimates of the number of trees/ha provided by expert judgment [9] **(Table 5.3)**

Table 5.2 Evergreen Fruit & Olive Trees

Evergreen Trees	Area 1993[7] (ha)	Area 1996[8] (ha)	Increase(+)/ Decrease(-) per year (ha)	Estimated Area (1994) (ha)	Trees/ha[9]	Trees
Banana	3353.5	3005	-116.16	3237.34	2000	6474680
Citrus	12728.8	14087	+452.73	13181.53	450	5931688
Olive	42608	51552	+2981.33	45589.33	210	9573760
Total				**62008.2**		**21980128**

Table 5.3 Deciduous Fruit Trees

Deciduous Trees	Area 1993[7] (ha)	Area 1996[8] (ha)	Increase(+)/ Decrease(-) per year (ha)	Estimated Area (1994) (ha)	Trees/ha[9]	Trees
Apple and Others	38798.6	55910	+5703.8	**44502.4**	625	**27814000**

Since no studies on annual growth rate for fruit trees have been carried out in Lebanon, the default values of annual growth rate for evergreen forest (3.0 tdm/ha) and for deciduous forest (2.0 tdm/ha) were used.
As required by worksheet 5-1 (sheet 1 of 3), the following calculation have been made to come out with the annual growth rate (ktdm for 1000 trees):

The estimated number of trees/ha for the evergreen trees is:
total evergreen trees
total evergreen trees area
21980128trees/62008.2ha= 354 trees/ha **(Table 5.2)**

The estimated annual growth rate for 1000 evergreen trees in ktdm is:
annual growth rate for evergreen forest x 1000 trees
number of trees/ha for evergreen trees
0.003ktdm/ha x 1000 trees =0.008474 ktdm
354 trees/ha

The estimated annual growth rate for 1000 deciduous trees in ktdm/trees is:
annual growth rate for deciduous forest x 1000 trees
number of trees/ha for decisuous trees
0.002 ktdm/ha x 1000 trees = 0.0032 ktdm **(Table 5.3)**
625 trees/ha

Therefore, the following figures are used in the worksheet **5-1 (sheet 1 of 3)** to compute the total carbon uptake increment by farm and village trees:
Evergreen fruit and olive trees: 21980 thousand trees
Annual growth rate for 1000 evergreen trees: 0.008474 ktdm
Deciduous fruit and olive trees: 27814 thousand trees
Deciduous fruit and olive trees: 0.0032 ktdm

B.2.2. Urban trees

The only official data for urban trees are the number of trees in municipal Beirut and the city surface (Municipality of Beirut). Although several responsibles in different public line organizations (MoPW and several municipalities) have been interviewed, no data related to urban trees in Lebanon could be found. Rough estimates on urban trees were reached by a rapid field assessment conducted by the working team.

It must be pointed out that the coastal zone and few inland cities where the Lebanese population is mainly concentrated are considered as the area of concern in this field assessment. Therefore the number of urban trees was estimated as the following:

i- The urban coastal zone is assumed to have one cover rate of urban trees (trees/ha) while the inland cities were divided into two categories, one (including Aley, Beit-Meiri-Broumana-Baabdat, Bhamdoun Chtoura-Taalabaya-Jlala, Zahle, and Jezzine) is assumed to have a cover rate higher than the other (including Nabatyeh and Baalback only).

ii- Five cities were selected as representative of the urban area : Tripoli, Beirut and Saida have been chosen from the coastal zone. Zahle was assumed to represent inland cities with a higher cover rate, while Nabatyeh those with a lower cover rate.

iii- The areas of the urban coastal zone and the inland cities mentioned in (*i*) have been estimated at the NCRS by image processing using SPOT image 1992, assuming that the urban growth between 1992 and 1994 has mostly occurred within the urban area.

iv- Representative streets have been chosen within each of the selected cities. The number of trees was counted in the chosen streets. The length and the width of the streets were also field-assessed. This allowed to estimate the streets cover rate of each of the selected city. **(Table 5.4)**

v- It was assumed that trees in urban zone exist in the streets and squares only. According to the law 25% of urban areas are dedicated to the roads and squares. Therefore, the streets cover rate represent four times the cover rate of the city.

vi- The number of trees in inland cities has been calculated by multiplying the surface of each city as computed at the NCRS by the respective cover rate of the city as calculated in (*v*)..

vii- The number of trees in the urban coastal zone has been calculated by multiplying the surface of the urban coastal zone as computed at the NCRS by the average cover rate of Beirut, Tripoli and Saida (total number of trees divided by the total surface) **Table 5.5.**

viii- It was assumed that in the coastal zone all trees are evergreen, while some inland cities have deciduous trees only. **(Tables 5.5, 5.6, 5.7)**

ix- Since no studies on annual growth rate for trees have been carried out in Lebanon, the default values of annual growth rate for evergreen forest (3.0 tdm/ha) and for deciduous forest (2.0 tdm/ha) were used.

Table 5-4 Streets Cover Rate of Selected cities

The total evergreen urban trees as estimated by our working team is:
total evergreem trees in the coastal zone **(Table 5-5)** + total evergreen trees in inland cities **(Table 5-6)**
395556 + 51380= 446936 trees or roughly 450000 trees

The total evergreen urban area is:
coastal zone area **(Table 5-5)** + total inland cities area which contains evergreen trees **(Table 5-6)**
9 418 + 1835 = 11253 ha

The evergreen urban cover rate is:
450000 trees / 11253ha = 40 trees/ha

The annual growth rate for 1000 evergreen urban trees is:

$$\frac{\text{annual growth rate for evergreen forest trees x 1000 trees}}{\text{evergreen cover rate}}$$

$$\frac{0.003\text{ktdm/ha x 1 000trees}}{40\text{ trees/ha}} = 0.075\text{ ktdm}$$

The total deciduous urban trees as estimated by our working team is:
35735 trees or roughly 36000 trees **(Table 5-7)**

The total deciduous urban area is: 1790.5ha **(Table 5-7)**

The deciduous urban cover rate is: 36000/1790.5ha = 20 trees/ha

The annual growth rate for 1000 deciduous urban trees is:

$$\frac{\text{annual growth rate for deciduous forest trees x 1000 trees}}{\text{deciduous cover rate}}$$

$$\frac{0.002\text{/ha x 1000trees}}{20\text{trees/ha}} = 0.1\text{ ktdm}$$

Therefore, the following figures are used in the **worksheet 5-1 (sheet 1 of 3)** to compute the total carbon uptake increment by urban trees:
Evergreen urban trees: 450 thousand trees
Annual growth rate for 1000 evergreen urban trees: 0.075ktdm
Deciduous urban trees: 36 thousand trees
Annual growth rate for 1000 evergreen urban trees: 0.1 ktdm

As a result the **total carbon uptake increment by forest trees and non-forest trees** (farm and village trees, and urban trees) **is 263 kt C worksheet 5-1 sheet 1 of 3).**

[Recommendation by team member: Photogrametry technique is an accurate method for future collection of data related to forest trees and non-forest trees using aerial photos scale:1/50000].

C. Biomass loss

As required in worksheet 5-1 (sheet 2 of 3), the biomass loss was computed only from data on fuelwood consumed collected from two sources:

1- 200-250 kt for 1994 [4]

2- 200 kt/yr (a survey in 50 villages from Kesrouan and Bekaa conducted by students under the supervision of Prof. Chedid R [12].

The value 200 kilotons per year has been selected with the assumption that the fuelwood consumption for 1998 is the same for 1994.

As a result of **section 5.2** CO_2 annual emission (-) or removal (+) by the submodule changes in forest and other woody biomass stocks has been calculated **worksheet 5-1 (sheet 3 of 3). For Lebanon the annual CO_2 removal by changes in forest and other woody biomass stocks is 600.624 kt.**

5.3 Forest and Grassland Conversion

A. Introduction

Forest and grassland conversion to permanent cropland is not an activity in Lebanon. Clearing forest for cropland may take place on a limited scale, but this practice when it occurs is illegal. Requested data on that issue are not available [4]. Consequently, calculation of estimates of CO_2 emissions due to forest/grassland conversion is limited to the carbon dioxide emitted by burning aboveground biomass on-site (immediate emissions in 1994) which occurs from natural and man made woodland fires. The carbon dioxide released from soil is taken into account in **section 5.5.** Burning biomass on-site is also a significant source of non-CO_2 trace gases (CH_4, N_2O, CO and NO_x) and their emission estimates were calculated in this submodule. It must be noticed that the net CO_2 emissions from fuelwood consumption appears as a loss of biomass stocks in **section 5.2.C,** and non-CO_2 trace gases from fuelwood consumption were considered in the energy module.

B. Carbon released by Burning Aboveground Biomass On-Site

The woodland area in Lebanon is mainly affected by natural and man made forest fires. A list of the areas ravaged by fires that occurred in Lebanon in 1994 has been provided by the MoE. The area that covers woodland devastated by fires in Lebanon for the inventory year 1994 is around 7500 ha. The values of this affected area (mostly forest area) need to be converted to tons of dry biomass burned. No studies on measured of dry matter in aboveground biomass have been carried out in Lebanon up to date, and since the only default values

of dry matter for temperate forests are for coniferous (220-295 tdm/ha) and for broadleaf (175-250 tdm/ha), the subdivision of forests on coniferous and broadleaf was selected as above mentioned in **section 5.2.B.**

- Coniferous: around 40% of the total forest area
  Broadleaf: around60% of the total forest area [3]

- Coniferous: around 50% of the total forest area
  Broadleaf: around 50% of the total forest area [4]

The average of these two sources was used. **The forest area is assumed to be made up of 45% of coniferous and 55% of broadleaf.** Therefore **the areas affected by fire were 3375 ha for coniferous and 4125 ha for broadleaf.**

It was assumed that all these areas were completely burned, therefore the quantity of biomass burned on-site is obtain by multiplying the burned area of each category by respective dry matter (the average of 257.5 tdm for coniferous and 212.5 for broadleaf).

Quantity of biomass burned on-site in coniferous forest is:
0.2575 ktdm/ha x 3375 ha = 869.0625 ktdm

Quantity of biomass burned on-site in broadleaf forest is:
0.2125 ktdm/ha x 4125 ha = 876.5625 ktdm.

The following figures are used in worksheet **5-2 sheet (sheet 2 of 5).**
quantity of biomass burned on site for coniferous: 869.0625 ktdm
quantity of biomass burned on site for deciduous: 876.5625 ktdm

As a result, **the quantity of carbon released from biomass burned (forest fires) worksheet 5-2 (sheet 2 of 5) is: 785. 53125 kt C.**

Worksheet 5-2 (sheet 5 of 5) converts the C released into CO_2 emission. **The CO_2 emitted from forest fires is 2880. 28125 Gg.**

The non-CO_2 trace gases emissions from on-site burning of forests (forest fires) are calculated in **worksheet 5-3 (sheet 1 of 1).**

CH_4 and CO are estimated as ratios to the carbon flux (785.53125 kt C) emitted during forest fires worksheet 5-2 (sheet 2 of 5). Total nitrogen content is estimated based on the nitrogen-carbon ratio (0.01). N_2O and NO_X are estimated as ratios to total nitrogen.

As a result, **Trace gas emissions from forest fires are:**

12.5685 Gg of CH_4
109.97437 Gg of CO
0.0864084 Gg of N_2O
3.1230477 Gg of NO_X

5.4 Abandonment of Managed Lands

Different socio-economic factors, namely migration (external and internal), war and the generally low income from agriculture have been the main agents to abandonment of the ancient terraced lands in Lebanon, particularly in Mount Lebanon. It is estimated that there are about 90 000 ha of terraces in Lebanon, of which about 40% (36 000 ha) are either not being maintained or have been abandoned [12].

Nevertheless, some of the abandoned land may have been managed again or may have regrown towards a natural state, but there is no quantitative data on that issue [4].

In the basic calculation of net CO_2 removals in biomass accumulation resulting from the abandonment of managed land, only abandoned lands which are regrowing towards a natural state should be included. Lands which do not regrow or degrade should be ignored in this calculation. Consequently there are no items to be taken into account in this submodule.

5.5. CO_2 Emissions and Uptake by Soils from Land-Use Change and Management

A. Introduction

The soils in Lebanon are typically Mediterranean in character, exhibiting similarities related to climate, exposure, slope, lithology and vegetation. Most of the soils are calcareous, except for the sandy soils formed on the basal Cretaceous strata. The most widely represented soils are the Terra-Rossa, the Inceptisols and the Rendzinas. On the steep landscapes of Lebanon and Anti-Lebanon, where water erosion can be extreme, the fersiallitic soils (Terra-Rossa) often develop into Lithosols [3].

According to several experts judgments [13,14,15,16]. Organic soils in Lebanon are extremely rare. Consequently, conversion of organic soils to agriculture or plantation forestry is merely occurring in Lebanon. And since most of the soils in Lebanon are calcareous (basic soils), liming is not used in Lebanon. Therefore, the calculation of CO_2 emissions or uptake by soil in this submodule is limited to changes in carbon stored in soil and litter of mineral soils due to changes in agricultural land-use practices.

B. Changes in Mineral Soil Carbon Stocks

The net carbon fluxes must be calculated on the basis of changes in soil carbon stocks over a twenty-year period. In this context, the needed data relate to 1994 (the inventory year), and 1974 (for twenty years prior to the current inventory year).They must include for these two years:

- Agricultural land-use practices in Lebanon;
- The distribution (areas) of different soil type according to each agricultural land-use practices:

A lot of efforts have been put on that issue and several experts have been interviewed, namely Dr. Khoury W.[9], and Dr. Baalbaki R.[17] in addition to the experts mentioned in section **5.5.A**. They all agree that the agricultural land-use practices could be estimated only for 1994, while the distribution (areas) of different soil type according to agricultural land-use practices could not be established neither for 1994, nor for 1974.

Therefore, the data collected and related to the present module are the following:
- Estimates on soil type for selected areas in Lebanon [13,14].
- The extend of irrigation practice as a part of total cultivated land [8]
- Estimates of current agricultural land-use practices in Lebanon [9].
- Estimates on areas for 1974 and 1994 of different soil type by land-use classes based on the FAO land-use map,1991 [3].
- Unified soil map of Lebanon (scale 1/50000) with database on soil in SOTER methodology (ongoing project "Assessment & Mapping of land Resources using Remote sensing & GIS techniques" financed by LNCSR with the cooperation of GORS (Syria) and the Lebanese University, started 1997, expected to be achieved 1999).

The above mentioned sources could be useful for updating purposes, but all data available to date are not sufficient for the calculation of net carbon fluxes on the basis of changes in soil carbon stocks in this submodule.

5.6 REFERENCES

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15. DR. HAJJ .S, Professor at the faculty of Agriculture, Lebanese University - Beirut.(pers.comm. 1998)

16. DR. MOUJABER .M, Professor at the faculty of Agriculture, University of Kaslik. (pers.comm. 1998)

17. DR. BAALBAKI .R, Professor at the faculty of Agriculture, A.U.B - Beirut. (pers.conn. 1998)

Table 5 Sectoral Report For Land-Use Change and Forestry

Sectoral Report for National Greenhouse Gas Inventories (Gg)						
Green House Gas Source snd Sink Categories	$CO_{2\ Emiss}$	CO_{2Remov}	CH_4	N_2O	NO_X	CO
Total Land-Use Change and Forestry	2880.28125	-600.62442	12.5685	0.0864083	3.1230477	109.97437
A Changes in Forest and Other Woody Biomass Stock						
1 Tropical Forests						
2 Temperate Forests		-600.62442				
3 Boreal Forests						
4 Grasiass/ Tundra						
5 Other(please specify)						
B Forest and Grassland Conversion						
1 Tropical Forests						
2 Temperate Forests	2880.28125		12.5685	0.0864083	3.1230477	109.97437
3 Boreal Forests						
4 Grasiass/ Tundra						
5 Other(please specify)						
C Abandonment of Managed Lands						
1 Tropical Forests						
2 Temperate Forests						
3 Boreal Forests						
4 Grasiass/ Tundra						
5 Other(please specify)						
D CO_2 Emissions and Removals from Soil						
E Other(please specify)						

SECTOR 6. WASTE MANAGEMENT

6.1 INTRODUCTION

The waste management section of this report deals with two sectors: land disposal of solid waste and wastewater treatment. It provides background information on the type of emissions that contribute to the greenhouse gases from these two sectors, presents the current status in Lebanon of both sectors, describes the methodology followed to estimate the corresponding emissions, and presents the results obtained regarding greenhouse emissions which will be evaluated in the context of their potential contribution to the global warming effect. This section does not estimate emissions from solid waste incineration which is addressed in the energy sector.

6.2 BACKGROUND INFORMATION

Solid waste including municipal, commercial and industrial wastes, as well as municipal wastewater contains a large percentage of organic materials which can decompose under appropriate environmental conditions. In the absence of oxygen (anaerobic conditions), the decomposition process produces primarily methane (CH_4) and carbon dioxide (CO_2) and insignificant quantities of other gases. This process is carried to completion through a series of microbial populations the most important of which are referred to as methanogens or methane producing bacteria. These latter are sensitive to the waste composition and several environmental factors such as temperature, pH, and availability of nutrients. Assuming that favorable conditions for methane production persists, the objective of the present work is to estimate the amount and type of emissions from solid waste disposal and wastewater treatment.

6.3 SECTOR STATUS IN LEBANON

A. SOLID WASTE

Until recently, a comprehensive approach to solid waste management in Lebanon has been virtually absent. For the project year 1994, slow burning and uncontrolled dumping on hillsides and on sea shores were still the common methods practiced for solid waste disposal. In urban areas, uncontrolled open dumps became quite large particularly along the coastal front (The Normandy and Burj Hammoud sites in Beirut, and the Nahr Abu Ali site in Tripoli, etc.). Incineration was also practiced at two relatively old facilities (Karantina and Amrousiyeh). Certainly the trend is changing and there is a great deal of efforts to develop integrated solid waste management systems for most areas in Lebanon, particularly large urban areas. These efforts center around the construction of many well controlled sanitary landfills in combination with sorting, recycling, and composting facilities.

As such, data on solid waste disposal quantities for the target year of 1994 are relatively unreliable because of the uncontrolled nature of waste disposal and the general absence of weighing scales at disposal facilities. Therefore, the total daily quantity of waste generated has been generally expressed as a daily per capita generation rate multiplied by the number of population. Often these rates account for solid waste from commercial and industrial sources since the latter are not separated from regular household waste.

Following this approach, several survey studies have been conducted to estimate waste generation rates by examining small daily samples from a large number of communities of different sizes. The most relevant of these studies with respect to the 1994 target year, is a survey conducted by the American University of Beirut [1, 2]. Table 6-1 presents generation rates for different localities (Caza) in Lebanon as reported in this study.

Table 6-1. Solid waste generation rates for different Cazas

Caza		Generation Rate kg/capita/day
Aley		0.78
Baabda		0.86
Beirut		0.74
Chouf		0.64
Kesrouan		0.77
Metn		0.70
Tripoli		0.64
Zahle		0.95
Other Communities	Highest Lowest	1.61 0.35

For estimation purposes, a rate of 0.8 kg/capita/day has been commonly used [3]. Using this rate coupled with numbers on population estimates for the target year 1994, the total quantity of solid waste produced in different localities (Mohafazat) of Lebanon are calculated as presented in Table 6-2.

Table 6-2. Total quantity of solid waste generation for different Mohafazats

Mohafazat	1994 Population '000	1994 Solid waste '000 tons/year
Greater Beirut Area	1,165	340.1
Mount Lebanon	695	202.9
Bekaa	460	134.3
North Lebanon	770	224.8
South Lebanon	635	185.4
Total Lebanon	3,725	1087.7

The composition of the solid waste quantities reported above vary substantially with socio-economic conditions, location, season, waste collection and disposal methods, sampling and sorting procedures, and many other factors. Table 6-3 presents average composition of unsorted municipal solid waste from the Beirut area. Despite the variability in its composition, solid waste in Lebanon as in most developing countries can be characterized by a high percentage of total organic content with relatively elevated moisture content.

Table 6-3. Composition of unsorted MSW [1, 2]

Waste Category	Average Composition % by weight
Paper/cardboard	11.3
Food waste	62.4
Diapers/garments	4.2
Plastics	11.0
Glass/Brick	5.6
Metals	2.9
Other (wood)	2.6

B. WASTEWATER

Similar to solid waste, municipal wastewater management in Lebanon has been absent particularly during the many years of civil unrest during which existing treatment plants were destroyed and/or put out of operation. The general trend for wastewater management in urban areas along the seashores where the greater majority of the population resides, has been limited to a deteriorated wastewater collection system that typically discharges into the sea. In other urban as well as rural areas, untreated wastewater is directly dumped into rivers, irrigation channels, valleys, and ravines as well as septic systems and then land disposal.

While numerous projects are underway to construct treatment plants around the country, for the target year 1994 and today, there are virtually no operational wastewater treatment plants in Lebanon.

Data on wastewater quantities for the target year of 1994 are typically estimated using a daily per capita average wastewater generation rate multiplied by the number of population. The daily per capita average rate can vary with location and season. For estimation purposes, a rate of 120 liter/capita/day has been reportedly commonly used for Lebanon [3, 4].

Wastewater is typically characterized in terms of several parameters such as Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and nitrates amongst other parameters. Table 6-4 summarizes available information on wastewater characteristics in Lebanon [4].

Table 6-4. Typical wastewater characteristics in Lebanon

Parameter	Range (mg/l)	Average (mg/l)
BOD	30-230	128
COD	250-820	630
Nitrate-N	30-160	100

Using average per capita wastewater generation rate and average wastewater characteristics with the population estimates mentioned above, the total yearly quantity and quality of wastewater generated during the target year 1994, are summarized in Table 6-5 for different localities (Mohafazat) in Lebanon.

Table 6-5. Total quantity of wastewater generation for different Mohafazats

Mohafazat	1994 Population '000	1994 Wastewater 'Mm^3/year	1994 BOD '000 t/year	1994 COD '000 t/year	1994 N '000 t/year
Greater Beirut Area	1,165	51.0	6.5	32.0	5.1
Mount Lebanon	695	30.4	3.9	19.2	3.0
Bekaa	460	20.1	2.6	12.8	2.0
North Lebanon	770	33.7	4.3	21.2	3.4
South Lebanon	635	27.8	3.5	17.2	2.7
Total Lebanon	3,725	163.0	20.8	102.4	16.2

6.4 METHODOLOGY FOR EMISSION ESTIMATION

A. SOLID WASTE

The revised default methodology developed by the Intergovernmental Panel on Climate Change (IPCC) was followed in order to estimate emissions from solid waste disposal on land [5]. The method follows a mass balance approach that involves estimating the degradable organic carbon (DOC) content of the solid waste to calculate the amount of CH_4 that can be generated by the waste.

Note that degradation processes will typically generate an approximately equivalent percent by volume of CO_2. However, the IPCC methodology assumes that the decomposition of organic material derived from biomass sources (e.g. crops, forests) which are regrown on an annual basis is the primary source of CO_2 released from waste. Hence, CO_2 emissions from land disposal of solid waste are not treated as net emissions from waste in the IPCC methodology. They are rather reported under the Agriculture and Land-Use Change and Forestry if biomass raw materials are not being sustainably produced.

The IPCC methodology is performed in four steps which are:

Step 1. Estimation of total MSW generated and disposed of in solid waste disposal sites.

The total MSW generated for the target year 1994 was estimated at 1087.7 $x10^3$ tonnes (Table 6-2). In Lebanon, about 70 percent of the population resides in urban areas. Waste generated from these areas is typically deposited in open dumps or incinerated thus accounting for about $761x10^3$ tonnes. Incineration at Amrousiyeh and Karantina accounted for about 400 tonnes/day [6] which are equivalent to $146x10^3$ tonnes per year. Therefore, the total amount of MSW disposed of in open dumps in the year 1994 is $615x10^3$ tonnes (0.615 Gg).

Step 2. Determination of the methane correction factor

As indicated above, the a good percentage of MSW is disposed of in open dumps. These dumps are unmanaged and have reached a depth far in excess of 5 meters. According to the IPCC guidelines, this corresponds to a methane correction factor of 0.8 (see attached IPCC sheet).

Step 3. Estimation of methane production rate per unit of waste

The methane production rate per unit of waste is a direct function of the waste composition which is presented in Table 6-3. The data in this table was used as described in the IPCC guidelines.

Step 4. Estimation of the total net annual methane emissions

The total net annual methane emissions was calculated assuming a zero value for the methane oxidation correction factor which is a reasonable assumption given the fact that solid waste is deposited in open dumps with no potential gas entrapment at the surface of the dump. Gas will be emitted unobstructed into the atmosphere leaving no time for oxidation to occur.

B. WASTEWATER

Similar to solid waste, the revised default methodology developed by the IPCC can be followed in order to estimate emissions from wastewater and industrial waste treatment [5]. The amount of methane that can be emitted is a direct function of the BOD and COD annual loading which are provided in Table 6-5. This information coupled with the type of treatment system utilized are required in order to estimate emissions.

6.5 RESULTS OF EMISSION ESTIMATION

A. SOLID WASTE

The total methane emissions from solid waste disposal on land is 83.7 tonnes (0.0837 Gg) approximately. Methane emission estimates are summarized Table 6 abou setoral report for waste and the attached IPCC sheets.

B. WASTEWATER

There are no emissions from wastewater and industrial waste handling systems because for the target year 1994, there was no treatment facilities in Lebanon. The wastewater (municipal, commercial, and industrial) was directly discharged into the sea, rivers, ravines, or septic tanks which indicate that methane or nitrous oxide emissions are insignificant if not non-existent. Note that this situation will change in the future as treatment plants are being constructed around the country and are expected to come into operation by the year 2,000.

6.6 REFERENCES

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Table 6 Sectoral Report For Waste

Sectoral Report for National Greenhouse Gas Inventories (Gg)						
Green House Gas Source snd Sink Categories	CO_2[1]	CH_4	N_2O	NO_X	CO	NMVOC
Total Waste	0	0.0837	0	0	0	0
A Solid Waste Disposal on Land						
1 Managed Waste Disposal on Land	0	0	0	0	0	0
2 Unmanaged Waste Disposal Sites	IE[1]	0.0837	0	0	0	0
3 Other (specify)						
B Waste Water Handling						
1 Industrial Wastewater	0	0	0	0	0	0
2 Domestic and Commercial Wastewater	0	0	0	0	0	0
3 Other (specify)	0	0	0	0	0	0
C Waste Incineration	IE[2]	IE[2]	IE[2]	IE[2]	IE[2]	IE[2]
D Other(please specify)	0	0	0	0	0	0

[1] Note that CO_2 from waste disposal and incineration should only be included if it stems from non-biological or inorganic waste sources

IE[1] Addressed in the Agriculture sector

IE[2] Addressed in the Energy Sector

APPENDIX 1
ENERGY IPCC WORKSHEETS

Module								
			Energy					
Submodule			CO_2 from Energy Sources (Reference Approach)					
Worksheet			1_1					
Sheet			1of 6					
			STEP 1					
			A Production	B Imports	C Exports	D International Bunkers	E Stock change	F Apparent Consumption
FUEL TYPES				(10^3 T)				A+B-C-D-E
Liquid Fossil	Primary Fuels	Crude Oil	NO	NO				
		Orimulsion	NO	NO				
		Natural Gas Liquids	NO	NO				
	Secondary Fuels	Gasoline	NO	1243.182				1243.182
		Jet Kerosene	NO	145.91		144		1.91
		Other Kerosene	NO	0.1				0.1
		Shale Oil	NO	NO				
		Gas / Diesel Oil	NO	818.123				818.123
		Residual fuel Oil	NO	1411.014				1411.014
		LPG	NO	146				146
		Ethane	NO	NO				
		Naphtha	NO	NO				
		Bitumen	NO	66				66
		Lubricants	NO	277.554585				277.5545852
		Petroleum Coke	NO	NO				
		Refinery Feedstocks	NO	NO				
		Other oil	NO	NO				
Liquid Fossil Totals			NO	4107.88359				4107.883585
Solid Fossil	Primary Fuels	Anthracite	NO	NO				
		Coking Coal	NO	180				180
		Other Bit. Coal	NO	NO				
		Sub-bit. Coal	NO	NO				
		Lignite	NO	NO				
		Oil Shale	NO	NO				
		Peat	NO	NO				
	Secondary Fuels	BKB & Patent Fuel	NO	NO				
		Coke Oven & Gas C	NO	NO				
Solid Fossil Totals			NO	180				180
Gaseous Fossil		Natural Gas (Dry)	NO	NO				
Total			NO	4287.88359				4287.883585
Biomass Total			NO	NO				
		Solid Biomass	160	1.56				161.56
		Liquid Biomass	NO	NO				
		Gas Biomass	NO	NO				

Module	Energy
Submodule	CO_2 from Energy Sources (Reference Approach)
Worksheet	1_1
Sheet	2of 5

			STEP 2	STEP 3			
			G Conversion Factor Tj/10^3 T	H Apparent Consumption (Tj)	I Carbon Emiss factor t C/Tj)	J Carbon Content (tC)	K Carbon Content (Gg C)
FUEL TYPES				FXG		H*I	J*10^-3
Liquid Fossil	Primary Fuels	Crude Oil					
		Orimulsion					
		Natural Gas Liquids					
	Secondary Fuels	Gasoline	44.8	55694.5536	18.9	1052627.063	1052.627
		Jet Kerosene	44.59	85.1669	19.5	1660.75455	1.660755
		Other Kerosene	44.75	4.475	19.6	87.71	0.08771
		Shale Oil	36	0		0	0
		Gas / Diesel Oil	43.33	35449.2696	20.2	716075.2457	716.0752
		Residual fuel Oil	40.19	56708.6527	21.1	1196552.571	1196.553
		LPG	47.31	6907.26	17.2	118804.872	118.8049
		Ethane	47.49	0	16.8	0	0
		Naphtha	45.01	0	20	0	0
		Bitumen	40.19	2652.54	22	58355.88	58.35588
		Lubricants	40.19	11154.9188	20	223098.3755	223.0984
		Petroleum Coke	31	0	27.5	0	0
		Refinery Feedstocks	44.8	0	20	0	0
		Other oil		0		0	0
Liquid Fossil Totals							
Solid Fossil	Primary Fuels	Anthracite		0	26.8	0	0
		Coking Coal	28	5040	25.8	130032	130.032
		Other Bit. Coal	28	0	25.8	0	0
		Sub-bit. Coal	28	0	26.2	0	0
		Lignite		0	29.6	0	0
		Oil Shale	9.4	0	29.1	0	0
		Peat		0	28.9	0	0
	Secondary Fuels	BKB & Patent Fuel		0	25.8	0	0
		Coke Oven & Gas Coke		0	29.5	0	0
Solid Fossil Totals							
Gaseous Fossil		Natural Gas (Dry)		0	15.3	0	0
Total				173696.837			3497.294
Biomass Total							
		Solid Biomass	29.9	4830.644	32	154580.608	154.5806
		Liquid Biomass		0	20	0	0
		Gas Biomass		0	30.6	0	0

Module	Energy						
Submodule	ources (Reference Approach)						
Worksheet	1_1						
Sheet	3of 5						
			STEP 4	STEP 5			STEP 6
			L Carbon Stored (Gg C)	M Net Carbon Emissions (Gg C)	N Fraction of Carbon Oxidised	O Actual Carbon Emissions (Gg C)	P Actual CO_2 Emissions (Gg CO_2)
	FUEL TYPES			M = (K-L)		O = (M*N)	=(O*[44/12])
Liquid Fossil	Primary Fuels	Crude Oil		0		0	0
		Orimulsion		0		0	0
		Natural Gas Liquids		0		0	0
	Secondary Fuels	Gasoline		1052.62706	0.99	1042.100792	3821.036
		Jet Kerosene		1.66075455	0.99	1.644147005	6.028539
		Other Kerosene		0.08771	0.99	0.0868329	0.318387
		Shale Oil					
		Gas / Diesel Oil		716.075246	0.99	708.9144933	2599.353
		Residual fuel Oil		1196.55257	0.99	1184.587045	4343.486
		LPG		118.804872	0.98	116.4287745	426.9055
		Ethane		0		0	0
		Naphtha		0		0	0
		Bitumen	58.35588	0	0.99	0	0
		Lubricants	111.549	111.549376	0.99	110.4338818	404.9242
		Petroleum Coke		0		0	0
		Refinery Feedstocks		0		0	0
		Other oil		0	0.995	0	0
Liquid Fossil Totals							11602.05
Solid Fossil	Primary Fuels	Anthracite		0		0	0
		Coking Coal	97.524	32.508	0.98	31.85784	116.8121
		Other Bit. Coal		0		0	0
		Sub-bit. Coal		0		0	0
		Lignite		0		0	0
		Oil Shale		0		0	0
		Peat		0		0	0
	Secondary Fuels	BKB & Patent Fuel		0		0	0
		Coke Oven & Gas Coke		0		0	0
Solid Fossil Totals							116.8121
Gaseous Fossil		Natural Gas (Dry)		0		0	0
Total							11718.86
Biomass Total							
		Solid Biomass		154.580608	0.98	151.4889958	555.4597
		Liquid Biomass		0		0	0
		Gas Biomass		0		0	0

Module	Energy						
Submodule	ources (Reference Approach)						
Worksheet	1_1						
Sheet	tional Bunkers (International Marine & Air)						
TRANSPORT)							
		STEP1	STEP 2			STEP3	
		A Quantities Delivered 10^3	B Conversion Factor (Tj/ 10^3)	C Quantities Delivered (Tj)	D arbon Emissio Factor (t C/Tj)	E Carbon Content (t C)	F Carbon Content (gG C)
FUEL TYPES				C = (A*B)		E = (C*D)	E*10^-3
Solid Fossil	Other Bituminous Coal			0		0	0
	Sub-Bituminous Coal			0		0	0
Liquid Fossil	Gasoline			0		0	0
	Jet Kerosene	144	44.59	6420.96	19.5	125208.7	125.20872
	Gas / Diesel Oil			0		0	0
	Residual fuel Oil			0		0	0
	Lubricants			0		0	0
			Total	6420.96			

Module	Energy						
Submodule	ources (Reference Approach)						
Worksheet	1_1						
Sheet	nal Bunkers (International Marine and Air)						
TRANSPORT)							
		STEP 2		STEP 3			STEP 4
		G Fraction of Carbon Stored	H Carbon Stored (Gg C)	I Net Carbon Emissions (Gg C)	J Fraction of Carbon Oxidized	K tual Carbo Emissions (Gg C)	L Actual CO_2 Emissions (Gg CO_2)
FUEL TYPES			H = (F*G)	I = (F-H)		K = (I*J)	L=(K*44/12)
Solid Fossil	Other Bituminous Coal	0	0	0		0	0
	Sub-Bituminous Coal	0	0	0		0	0
Liquid Fossil	Gasoline	0	0	0		0	0
	Jet Kerosene	0	0	125.20872	0.99	123.9566	454.5076536
	Gas / Diesel Oil	0	0	0		0	0
	Residual fuel Oil	0	0	0		0	0
	Lubricants	0.5		0		0	0
						Total	454.5076536

Module	Energy
Submodule	CO2 from Energy
Worksheet	Auxiliary worksheet 1_1:Estimating carbon Stored in Products
Sheet	I of I

	A Estimated Fuel quantities 10^3 T	B Conversion Factor (Tj/units)	C Estimated uel quantitie (TJ)	D bon Emiss Factor (t C/Tj)	E Carbon Content (t C)
FUEL TYPES			C = (A*B)		E = (C*D)
Naphtha			0		0
Lubricants	277.5545	40.19	11154.9154	20	223098.3071
Bitumen	66	40.19	2652.54	22	58355.88
Coal Oils and T(from coking coal)	180	28	5040	25.8	130032
Natural Gas			0		0
Gas/Diesel Oil			0		0
LPG			0		0
Ethane			0		0
Other Fuels			0		0

	F Carbon Content	G Fraction of Carbon Stored	H Carbon Stored (Gg C)
FUEL TYPES	E*10^-3		H = (F*G)
Naphtha	0	0.8	0
Lubricants	223.0983071	0.5	111.549154
Bitumen	58.35588	1	58.35588
Coal Oils and T(from coking coal)	130.032	0.75	97.524
Natural Gas	0	0.33	0
Gas/Diesel Oil	0	0.5	0
LPG	0	0.8	0
Ethane	0	0.8	0
Other Fuels	0		0

MODULE	ENERGY					
SUBMODULE	CO_2 From Fuel Combustion By Source Categories(Tier 1)					
WORKSHEET	1-2 Step By Step Calculations					
SHEET	1 of 16	ENERGY INDUSTRIES				
	STEP 1	STEP 2		STEP 3		
Energy Industries	A Consumption 10^3 [T]	B Conversion Factor (Tj/10^3 T)	C Consumption (Tj)	D Carbon Emission Factor (t C/Tj)	E Carbon Content (t C)	F Carbon Content (Gg C)
			C=(A*B)		E=(C*D)	F=(E*10^{-3})
Crude Oil	NO					
Natural Gas Liquids	NO					
Gasoline	NO					
Jet Kerosene	NO					
Other Kerosene	NO					
Gas/Diesel Oil	48.65	43.33	2108.0045	20.2	42581.6909	42.5816909
Residual Fuel Oil	1124.07	40.19	45176.3733	21.1	953221.4766	953.2214766
LPG	NO					
Ethane	NO					
Naphtha	NO					
Lubricants	198.2532751	40.19	7967.799127	20	159355.9825	159.3559825
Petroleum Coke	NO					
Refinery Gas	NO					
Anthracite	NO					
Coking Coal	NO					
Other Bituminous Coal	NO					
Lignite	NO					
Peat	NO					
Patent Fuel	NO					
Brown Coal Briquettes	NO					
Coke Oven Coke	NO					
Gas Coke	NO					
Gas Works Gas	NO					
Coke Oven Gas	NO					
Blast Furnace Gas	NO					
Natural Gas	NO					
Municipal Solid Waste	NO					
Industrial Waste	NO					
		Total	55252.17693			
Memo items:						
Wood/Wood Waste	NO					
Charcoal	NO					
Other Solid Biomass	NO					
Liquid Biomass	NO					
Gaseous Biomass	NO					
		Total Biomass				

	STEP 4			STEP 5		STEP 6
Energy Industries	G Fraction of Carbon Stored	H arbon Stored (Gg C)	I Net Carbon Emissions (Gg C)	J Fraction of Carbon Oxidized	K ctual Carbon Emissions (Gg C)	L Actual CO_2 Emissions (Gg CO_2)
		H=(F*G)	I=(F-H)		K=(I*J)	L=(K*[44/12])
Crude Oil		0	0		0	0
Natural Gas Liquids		0	0		0	0
Gasoline		0	0		0	0
Jet Kerosene		0	0		0	0
Other Kerosene		0	0		0	0
Gas/Diesel Oil		0	42.5816909	0.99	42.15587399	154.571538
Residual Fuel Oil		0	953.2214766	0.99	943.6892619	3460.19396
LPG		0	0		0	0
Ethane		0	0		0	0
Naphtha		0	0		0	0
Lubricants	0.5	79.67799127	79.67799127	0.99	78.88121135	289.2311083
Petroleum Coke		0	0		0	0
Refinery Gas		0	0		0	0
Anthracite		0	0		0	0
Coking Coal		0	0		0	0
Other Bituminous Coal		0	0		0	0
Lignite		0	0		0	0
Peat		0	0		0	0
Patent Fuel		0	0		0	0
Brown Coal Briquettes		0	0		0	0
Coke Oven Coke		0	0		0	0
Gas Coke		0	0		0	0
Gas Works Gas		0	0		0	0
Coke Oven Gas		0	0		0	0
Blast Furnace Gas		0	0		0	0
Natural Gas		0	0		0	0
Municipal Solid Waste		0	0		0	0
Industrial Waste		0	0		0	0
		0	0		0	0
		0	0		0	0
		0	0		0	0
					Total	3903.996606
Memo items:						
Wood/Wood Waste						
Charcoal						
Other Solid Biomass						
Liquid Biomass						
Gaseous Biomass						
					Total Biomass	

MODULE	ENERGY					
SUBMODULE	CO_2 From Fuel Combustion By Source Categories(Tier 1)					
WORKSHEET	1-2 Step By Step Calculations					
SHEET	3 of 16					
	STEP 1	STEP 2		STEP 3		
Manufacturing Industries and Construction	A Consumption 10^3 T	B Conversion Factor (Tj/10^3 T)	C Consumption (Tj)	D Carbon Emission Factor (t C/Tj)	E Carbon Content (t C)	F Carbon Content (Gg C)
			C=(A*B)		E=(C*D)	F=(E*10^{-3})
Crude Oil	NO					
Natural Gas Liquids	NO					
Gasoline	NE					
Jet Kerosene	NO					
Other Kerosene	NE					
Gas/Diesel Oil	425.424	43.33	18433.62192	20.2	372359.1628	372.3591628
Residual Fuel Oil	286.944	40.19	11532.27936	21.1	243331.0945	243.3310945
LPG	21.06	47.31	996.3486	17.2	17137.19592	17.13719592
Ethane	NO					
Naphtha	NO					
Lubricants	79.30131004	40.19	3187.119651	20	63742.39301	63.74239301
Petroleum Coke	NO					
Refinery Gas	NO					
Anthracite	NO					
Coking Coal	180	28	5040	25.8	130032	130.032
Other Bituminous Coal	NO					
Lignite	NO					
Peat	NO					
Patent Fuel	NO					
Brown Coal Briquettes	NO					
Coke Oven Coke	NO					
Gas Coke	NO					
Gas Works Gas	NO					
Coke Oven Gas	NO					
Blast Furnace Gas	NO					
Natural Gas	NO					
Municipal Solid Waste	1.5	43.33	64.995	20.2	1312.899	1.312899
Industrial Waste	NO					
		Total	39254.36453			
Memo items:						
Wood/Wood Waste	NO					
Charcoal	NO					
Other Solid Biomass	NO					
Liquid Biomass	NO					
Gaseous Biomass	NO					
		Total Biomass				

	STEP 4			STEP 5		STEP 6
Manufacturing Industries and Construction	G Fraction of Carbon Stored	H Carbon Stored (Gg C)	I Net Carbon Emissions (Gg C)	J Fraction of Carbon Oxidized	K Actual Carbon Emissions (Gg C)	L Actual CO_2 Emissions (Gg CO_2)
		H=(F*G)	I=(F-H)		K=(I*J)	L=(K*[44/12])
Crude Oil		0	0		0	0
Natural Gas Liquids		0	0		0	0
Gasoline		0	0		0	0
Jet Kerosene		0	0		0	0
Other Kerosene		0	0		0	0
Gas/Diesel Oil		0	372.3591628	0.99	368.6355712	1351.663761
Residual Fuel Oil		0	243.3310945	0.99	240.8977836	883.291873
LPG		0	17.13719592	0.98	16.794452	61.57965734
Ethane		0	0		0	0
Naphtha		0	0		0	0
Lubricants	0.5	31.87119651	31.87119651	0.99	31.55248454	115.6924433
Petroleum Coke		0	0		0	0
Refinery Gas		0	0		0	0
Anthracite		0	0		0	0
Coking Coal	0.75	97.524	32.508	0.98	31.85784	116.81208
Other Bituminous Coal		0	0		0	0
Lignite		0	0		0	0
Peat		0	0		0	0
Patent Fuel		0	0		0	0
Brown Coal Briquettes		0	0		0	0
Coke Oven Coke		0	0		0	0
Gas Coke		0	0		0	0
Gas Works Gas		0	0		0	0
Coke Oven Gas		0	0		0	0
Blast Furnace Gas		0	0		0	0
Natural Gas		0	0		0	0
Municipal Solid Waste		0	1.312899	0.99	1.29977001	4.76582337
Industrial Waste		0	0		0	0
		0	0		0	0
		0	0		0	0
		0	0		0	0
					Total	2533.805638
Memo items:						
Wood/Wood Waste						
Charcoal						
Other Solid Biomass						
Liquid Biomass						
Gaseous Biomass						
					Total Biomass	

MODULE	ENERGY					
SUBMODULE	CO_2 From Fuel Combustion By Source Categories(Tier 1)					
WORKSHEET	1-2 Step By Step Calculations					
SHEET	5 of 16 Transport					
	STEP 1	STEP 2		STEP 3		
Transport	A Consumption 10^3 T	B Conversion Factor (Tj/10^3 T)	C Consumption (Tj)	D Carbon Emission Factor (t C/Tj)	E Carbon Content (t C)	F Carbon Content (Gg C)
			C=(A*B)		E=(C*D)	F=(E*10^{-3})
Domestic Aviation			0		0	0
Gasoline	NO					
Jet Kerosene	1.91	44.59	85.1669	19.5	1660.75455	1.66075455
		Subtotal	85.1669			
Road Transport						
Natural Gas	NO					
LPG	NO					
Gasoline	1242.8033	44.8	55677.58784	18.9	1052306.41	1052.30641
Gas/Diesel Oil	40.906	43.33	1772.45698	20.2	35803.631	35.803631
		Subtotal	57450.04482			
Rail Transport						
Gas/Diesel Oil	NO					
Residual Fuel Oil	NO					
Anthracite	NO					
Other Bituminous Coal	NO					
Coke Oven Coke	NO					
		Subtotal				
National Navigation						
Gasoline	0.378612	44.8	16.9618176	18.9	320.5783526	0.320578353
Gas/Diesel Oil	0.0292	43.33	1.265236	20.2	25.5577672	0.025557767
Residual Fuel Oil	NO					
Lubricants	NE					
Sub-Bituminous Coal	NO					
		Subtotal	18.2270536			
Pipeline Transport						
Natural Gas	NO					
		Subtotal				
		Total Transport	57553.43877			
Memo items:						
Liquid Biomass	NO					
		Total Biomass				

	STEP 4			STEP 5		STEP 6
Transport	G Fraction of Carbon Stored	H arbon Stored (Gg C)	I Net Carbon Emissions (Gg C)	J Fraction of Carbon Oxidized	K ctual Carbon Emissions (Gg C)	L Actual CO_2 Emissions (Gg CO_2)
		H=(F*G)	I=(F-H)		K=(I*J)	L=(K*[44/12])
Domestic Aviation		0	0		0	0
Gasoline		0	0		0	0
Jet Kerosene		0	1.66075455	0.99	1.644147005	6.028539017
		0	0		0	0
					Subtotal	6.028539017
Road Transport						
Natural Gas		0	0		0	0
LPG		0	0		0	0
Gasoline		0	1052.30641	0.99	1041.783346	3819.872269
Gas/Diesel Oil		0	35.803631	0.99	35.44559469	129.9671805
		0	0			0
					Subtotal	3949.839449
Rail Transport						
Gas/Diesel Oil		0	0		0	0
Residual Fuel Oil		0	0		0	0
Anthracite		0	0		0	0
Other Bituminous Coal		0	0		0	0
Coke Oven Coke		0	0		0	0
		0	0		0	0
					Subtotal	0
National Navigation						
Gasoline		0	0.320578353	0.99	0.317372569	1.16369942
Gas/Diesel Oil		0	0.025557767	0.99	0.02530219	0.092774695
Residual Fuel Oil		0	0		0	0
Lubricants		0	0		0	0
Sub-Bituminous Coal		0	0		0	0
		0	0		0	0
					Subtotal	1.256474115
Pipeline Transport						
Natural Gas		0	0		0	0
		0	0		0	0
					Subtotal	0
					Total Transport	3957.124463
Memo items:						
Liquid Biomass						
					Total Biomass	

MODULE	ENERGY
SUBMODULE	CO_2 From Fuel Combustion By Source Categories(Tier 1)
WORKSHEET	1-2 Step By Step Calculations
SHEET	7 of 16 Memo Items: International Bunkers

	STEP 1	STEP 2		STEP 3		
Memo Items: International Bunkers	A Consumption 10^3 T	B Conversion Factor (Tj/10^3 T)	C Consumption (Tj)	D Carbon Emission Factor (t C/Tj)	E Carbon Content (t C)	F Carbon Content (Gg C)
			C=(A*B)		E=(C*D)	F=(E*10^{-3})
Intl. Marine Bunkers						
Gasoline	NE					
Gas/Diesel Oil	NE					
Residual Fuel Oil	NE					
Lubricants	NE					
Sub-Bituminous Coal	NE					
		Total				
Intl. Aviation Bunkers						
Gasoline	NE					
Jet Kerosene	144	44.59	6420.96	19.5	125208.72	125.20872
		Total	6420.96			

	STEP 4			STEP 5		STEP 6
Memo Items: International Bunkers	G Fraction of Carbon Stored	H arbon Stored (Gg C)	I Net Carbon Emissions (Gg C)	J Fraction of Carbon Oxidized	K ctual Carbon Emissions (Gg C)	L Actual CO2 Emissions (Gg CO2)
		H=(F*G)	I=(F-H)		K=(I*J)	L=(K*[44/12])
Intl. Marine Bunkers		0	0		0	0
Gasoline		0	0		0	0
Gas/Diesel Oil		0	0		0	0
Residual Fuel Oil		0	0		0	0
Lubricants		0	0		0	0
Sub-Bituminous Coal		0	0		0	0
		0	0		0	0
					Total	0
Intl. Aviation Bunkers		0	0		0	0
Gasoline		0	0		0	0
Jet Kerosene	0	0	125.20872	0.99	123.9566328	454.5076536
					Total	454.5076536

MODULE	ENERGY					
SUBMODULE	CO_2 From Fuel Combustion By Source Categories(Tier 1)					
WORKSHEET	1-2 Step By Step Calculations					
SHEET	9 of 16 Commercial/Institutional Sector					
	STEP 1	STEP 2		STEP 3		
Commercial/ Institutional Sector	A Consumption 10^3 T	B Conversion Factor (Tj/10^3)	C Consumption (Tj)	D Carbon Emission Factor (t C/Tj)	E Carbon Content (t C)	F Carbon Content (Gg C)
			C=(A*B)		E=(C*D)	F=(E*10^{-3})
Gasoline	NE					
Jet Kerosene	NO					
Other Kerosene	NE					
Gas/Diesel Oil	57.677	43.33	2499.14441	20.2	50482.71708	50.48271708
Residual Fuel Oil	NO					
LPG	14.58	47.31	689.7798	17.2	11864.21256	11.86421256
Anthracite	NO					
Other Bituminous Coal	NO					
Lignite	NO					
Brown Coal Briquettes	NO					
Coke Oven Coke	NO					
Gas Works Gas	NO					
Coke Oven Gas	NO					
Natural Gas	NO					
		Total	3188.92421			
Memo Items:						
Wood/Wood Waste	NO					
Charcoal	NO					
Other Solid Biomass	NO					
Liquid Biomass	NO					
Gaseous Biomass	NO					
		Total Biomass				

	STEP 4			STEP 5		STEP 6
Commercial/ Institutional Sector	G Fraction of Carbon Stored	H Carbon Stored (Gg C)	I Net Carbon Emissions (Gg C)	J Fraction of Carbon Oxidized	K Actual Carbon Emissions (Gg C)	L Actual CO_2 Emissions (Gg CO_2)
		H=(F*G)	I=(F-H)		K=(I*J)	L=(K*[44/12])
Gasoline		0	0		0	0
Jet Kerosene		0	0		0	0
Other Kerosene		0	0		0	0
Gas/Diesel Oil		0	50.48271708	0.99	49.97788991	183.252263
Residual Fuel Oil		0	0		0	0
LPG		0	11.86421256	0.98	11.62692831	42.63207047
Anthracite		0	0		0	0
Other Bituminous Coal		0	0		0	0
Lignite		0	0		0	0
Brown Coal Briquettes		0	0		0	0
Coke Oven Coke		0	0		0	0
Gas Works Gas		0	0		0	0
Coke Oven Gas		0	0		0	0
Natural Gas		0	0		0	0
		0	0		0	0
		0	0		0	0
		0	0		0	0
		0	0		0	0
					Total	225.8843335
Memo Items:						
Wood/Wood Waste						
Charcoal						
Other Solid Biomass						
Liquid Biomass						
Gaseous Biomass						
					Total Biomass	

MODULE	ENERGY					
SUBMODULE	CO_2 From Fuel Combustion By Source Categories(Tier 1)					
WORKSHEET	1-2 Step By Step Calculations					
SHEET	11 of 16 Residential Sector					
	STEP 1	STEP 2		STEP 3		
Residential Sector	A Consumption 10^3	B Conversion Factor (Tj/10^3)	C Consumption (Tj)	D Carbon Emission Factor (t C/Tj)	E Carbon Content (t C)	F Carbon Content (Gg C)
			C=(A*B)		E=(C*D)	F=(E*10^{-3})
Gasoline	NE					
Other Kerosene	0.1	44.75	4.475	19.6	87.71	0.08771
Gas/Diesel Oil	65.449	43.33	2835.90517	20.2	57285.28443	57.28528443
Residual Fuel Oil	NO					
LPG	110.36	47.31	5221.1316	17.2	89803.46352	89.80346352
Anthracite	NO					
Other Bituminous Coal	NO					
Sub-Bituminous Coal	NO					
Lignite	NO					
Peat	NO					
Patent Fuel	NO					
Brown Coal Briquettes	NO					
Coke Oven Coke	NO					
Gas Works Gas	NO					
Coke Oven Gas	NO					
Natural Gas	NO					
		Total	8061.51177			
Memo Items:						
Wood/Wood Waste	NE					
Charcoal	1.56	29.9	46.644	32	1492.608	1.492608
Other Solid Biomass	160	29.9	4784	32	153088	153.088
Liquid Biomass	NO					
Gaseous Biomass	NO					
		Total Biomass	4830.644			

	STEP 4			STEP 5		STEP 6
Residential Sector	G Fraction of Carbon Stored	H arbon Stored (Gg C)	I Net Carbon Emissions (Gg C)	J Fraction of Carbon Oxidised	K ctual Carbon Emissions (Gg C)	L Actual CO_2 Emissions (Gg CO_2)
		H=(F*G)	I=(F-H)		K=(I*J)	L=(K*[44/12])
Gasoline	0	0	0		0	0
Other Kerosene	0	0	0.08771	0.99	0.0868329	0.3183873
Gas/Diesel Oil	0	0	57.28528443	0.99	56.71243159	207.9455825
Residual Fuel Oil		0	0		0	0
LPG		0	89.80346352	0.98	88.00739425	322.6937789
Anthracite		0	0		0	0
Other Bituminous Coal		0	0		0	0
Sub-Bituminous Coal		0	0		0	0
Lignite		0	0		0	0
Peat		0	0		0	0
Patent Fuel		0	0		0	0
Brown Coal Briquettes		0	0		0	0
Coke Oven Coke		0	0		0	0
Gas Works Gas		0	0		0	0
Coke Oven Gas		0	0		0	0
Natural Gas		0	0		0	0
		0	0		0	0
		0	0		0	0
		0	0		0	0
		0	0		0	0
					Total	530.9577487
Memo Items:						
Wood/Wood Waste						
Charcoal	0	0	1.492608	0.98	1.46275584	5.36343808
Other Solid Biomass	0	0	153.088	0.98	150.02624	550.0962133
Liquid Biomass						
Gaseous Biomass						
					Total Biomass	555.4596514

MODULE	ENERGY					
SUBMODULE	CO_2 From Fuel Combustion By Source Categories(Tier 1)					
WORKSHEET	1-2 Step By Step Calculations					
SHEET	13 of 16 Agriculture/Forestry/Fishing					
	STEP 1	STEP 2		STEP 3		
Agriculture/Forestry Fishing	A Consumption 10^3	B Conversion Factor (Tj/10^3)	C Consumption (Tj)	D Carbon Emission Factor (t C/Tj)	E Carbon Content (t C)	F Carbon Content (Gg C)
			C=(A*B)		E=(C*D)	F=(E*10^{-3})
Mobile						
Gasoline	NE					
Jet Kerosene	NE					
Other Kerosene	NE					
Gas/Diesel Oil	NE					
Residual Fuel Oil	NO					
LPG	NE					
		Total				
Stationary						
Gasoline	NE					
Other Kerosene	NE					
Gas/Diesel Oil	179.987	43.33	7798.83671	20.2	157536.5015	157.5365015
Residual Fuel Oil	NO					
LPG	NE					
Anthracite	NO					
Coking Coal	NO					
Other Bituminous Coal	NO					
Lignite	NO					
Patent Fuel	NO					
Brown Coal Briquettes	NO					
Coke Oven Coke	NO					
Gas Works Gas	NO					
Natural Gas	NO					
		Total	7798.83671			
Memo Items:						
Mobile						
Liquid Biomass	NO					
Stationary						
Wood/Wood Waste	NE					
Charcoal	NE					
Other Solid Biomass	NE					
Liquid Biomass	NO					
Gaseous Biomass	NO					
		Total Biomass				

	STEP 4			STEP 5		STEP 6
Agriculture/Forestry Fishing	G Fraction of Carbon Stored	H arbon Stored (Gg C)	I Net Carbon Emissions (Gg C)	J Fraction of Carbon Oxidized	K ctual Carbon Emissions (Gg C)	L Actual CO_2 Emissions (Gg CO_2)
		H=(F*G)	I=(F-H)		K=(I*J)	L=(K*[44/12])
Mobile		0	0		0	0
Gasoline		0	0		0	0
Jet Kerosene		0	0		0	0
Other Kerosene		0	0		0	0
Gas/Diesel Oil		0	0		0	0
Residual Fuel Oil		0	0		0	0
LPG		0	0		0	0
		0	0		0	0
		0	0		0	0
					Total	0
Stationary		0	0		0	0
Gasoline		0	0		0	0
Other Kerosene		0	0		0	0
Gas/Diesel Oil		0	157.5365015	0.99	155.9611365	571.8575006
Residual Fuel Oil		0	0		0	0
LPG		0	0		0	0
Anthracite		0	0		0	0
Coking Coal		0	0		0	0
Other Bituminous Coal		0	0		0	0
Lignite		0	0		0	0
Patent Fuel		0	0		0	0
Brown Coal Briquettes		0	0		0	0
Coke Oven Coke		0	0		0	0
Gas Works Gas		0	0		0	0
Natural Gas		0	0		0	0
		0	0		0	0
		0	0		0	0
					Total	571.8575006
Memo Items:						
Mobile						
Liquid Biomass						
Stationary						
Wood/Wood Waste						
Charcoal						
Other Solid Biomass						
Liquid Biomass						
Gaseous Biomass						
					Total Biomass	

MODULE	ENERGY
SUBMODULE	CO_2 From Fuel Combustion By Source Categories(Tier 1)
WORKSHEET	1-2 Overview
SHEET	1 of 10

			A Crude Oil	B Orimulsion	C Natural Gas Liquids	D Gasoline	E Jet Kerosene
Fuel Consumption (TJ)							
Energy Industries							
Manufacturing Industries and Construction							
Transport	Domestic Aviation						85.1669
	Road					55677.58784	
	Railways						
	National Navigation					16.9618	
Other	Commercial/Institutional						
Sectors	Residential						
	Agriculture/Forestry/	Stationary					
	Fishing	Mobile					
Other(not elsewhere specified)							
Total			0	0	0	55694.54964	85.1669
Memo:International Marine Bunkers							
Memo:International Aviation Bunkers							6420.96
CO2 Emissions (Gg)							
Energy Industries							
Man. Industries and Construction							
Transport	Domestic Aviation						6.028539
	Road					3819.8723	
	Railways						
	National Navigation					1.16369	
Other	Commercial/Institutional						
Sectors	Residential						
	Agriculture/Forestry/	Staionary					
	Fishing	Mobile					
Other(not elsewhere specified)							
Total						3821.03599	6.028539
Memo:International Marine Bunkers							
Memo:International Aviation Bunkers							454.507653

MODULE	ENERGY
SUBMODULE	CO_2 From Fuel Combustion By Source Categories(Tier 1)
WORKSHEET	1-2 Overview
SHEET	2 of 10

			F Other Kerosene	G Shale Oil	H Gas/Diesel Oil	I Residual Fuel Oil	J LPG
Fuel Consumption (TJ)							
Energy Industries					2108	45176.3733	
Manufacturing Industries and Construction					18433.6219	11532.279	996.3486
Transport	Domestic Aviation						
	Road				1772.46		
	Railways						
	National Navigation				1.265236		
Other	Commercial/Institutional				2499.14441		689.78
Sectors	Residential		4.475		2835.90517		5221.1316
	Agriculture/Forestry/	Stationary			7798.8367		
	Fishing	Mobile					
Other(not elsewhere specified)							
Total			4.475	0	35449.23342	56708.6523	6907.2602
Memo:International Marine Bunkers							
Memo:International Aviation Bunkers							
CO2 Emissions (Gg)							
Energy Industries					154.5715	3460.194	
Man. Industries and Construction					1351.664	883.2919	61.57966
Transport	Domestic Aviation						
	Road				129.96718		
	Railways						
	National Navigation				0.0927747		
Other	Commercial/Institutional				183.25226		42.63207
Sectors	Residential		0.318387		207.9456		322.6938
	Agriculture/Forestry/	Staionary			571.8575		
	Fishing	Mobile					
Other(not elsewhere specified)							
Total			0.318387	0	2599.350815	4343.4859	426.90553
Memo:International Marine Bunkers							
Memo:International Aviation Bunkers							

MODULE	ENERGY					
SUBMODULE	CO_2 From Fuel Combustion By Source Categories(Tier 1)					
WORKSHEET	1-2 Overview					
SHEET	3 of 10					
			L Naphtha	M Lubricants	N Petroleum Coke	O Refinery Gas
Fuel Consumption		(TJ)				
Energy Industries				7967.7991		
Manufacturing Industries and Construction				3187.1196		
Transport	Domestic Aviation					
	Road					
	Railways					
	National Navigation					
Other	Commercial/Institutional					
Sectors	Residential					
	Agriculture/Forestry/	Stationary				
	Fishing	Mobile				
Other(not elsewhere specified)						
Total			0	11154.9187	0	0
Memo:International Marine Bunkers						
Memo:International Aviation Bunkers						
CO2 Emissions		(Gg)				
Energy Industries				289.2311		
Man. Industries and Construction				115.6924		
Transport	Domestic Aviation					
	Road					
	Railways					
	National Navigation					
Other	Commercial/Institutional					
Sectors	Residential					
	Agriculture/Forestry/	Staionary				
	Fishing	Mobile				
Other(not elsewhere specified)						
Total			0	404.9235	0	0
Memo:International Marine Bunkers						
Memo:International Aviation Bunkers						

MODULE	ENERGY						
SUBMODULE	CO_2 From Fuel Combustion By Source Categories(Tier 1)						
WORKSHEET	1-2 Overview						
SHEET	4 of 10						
			P Anthracite	Q Coking Coal	R Other tuminous Co	S ub-Bituminous Coal	T Lignite
Fuel Consumption		(TJ)					
Energy Industries							
Manufacturing Industries and Construction				5040			
Transport	Domestic Aviation						
	Road						
	Railways						
	National Navigation						
Other	Commercial/Institutional						
Sectors	Residential						
	Agriculture/Forestry/	Stationary					
	Fishing	Mobile					
Other(not elsewhere specified)							
Total			0	5040	0	0	0
Memo:International Marine Bunkers							
Memo:International Aviation Bunkers							
CO2 Emissions		(Gg)					
Energy Industries							
Man. Industries and Construction				116.812			
Transport	Domestic Aviation						
	Road						
	Railways						
	National Navigation						
Other	Commercial/Institutional						
Sectors	Residential						
	Agriculture/Forestry/	Staionary					
	Fishing	Mobile					
Other(not elsewhere specified)							
Total			0	116.812	0	0	0
Memo:International Marine Bunkers							
Memo:International Aviation Bunkers							

MODULE	ENERGY
SUBMODULE	CO_2 From Fuel Combustion By Source Categories(Tier 1)
WORKSHEET	1-2 Overview
SHEET	5 of 10

			U Oil Shale	V Peat	W Patent Fuel	X Brown Coal Briquettes	Y Coke Oven Coke
Fuel Consumption		(TJ)					
Energy Industries							
Manufacturing Industries and Construction							
Transport	Domestic Aviation						
	Road						
	Railways						
	National Navigation						
Other	Commercial/Institutional						
Sectors	Residential						
	Agriculture/Forestry/	Stationary					
	Fishing	Mobile					
Other(not elsewhere specified)							
Total			0	0	0	0	0
Memo:International Marine Bunkers							
Memo:International Aviation Bunkers							
CO2 Emissions		(Gg)					
Energy Industries							
Man. Industries and Construction							
Transport	Domestic Aviation						
	Road						
	Railways						
	National Navigation						
Other	Commercial/Institutional						
Sectors	Residential						
	Agriculture/Forestry/	Staionary					
	Fishing	Mobile					
Other(not elsewhere specified)							
Total			0	0	0	0	0
Memo:International Marine Bunkers							
Memo:International Aviation Bunkers							

MODULE	ENERGY
SUBMODULE	CO_2 From Fuel Combustion By Source Categories(Tier 1)
WORKSHEET	1-2 Overview
SHEET	6 of 10

			Z Gas Coke	AA Gas Works Gas	AB Coke Oven Gas	AC last Furnace Gas	AD Natural Gas
Fuel Consumption		(TJ)					
Energy Industries							
Manufacturing Industries and Construction							
Transport	Domestic Aviation						
	Road						
	Railways						
	National Navigation						
Other	Commercial/Institutional						
Sectors	Residential						
	Agriculture/Forestry/	Stationary					
	Fishing	Mobile					
Other(not elsewhere specified)							
Total			0	0	0	0	0
Memo:International Marine Bunkers							
Memo:International Aviation Bunkers							
CO2 Emissions		(Gg)					
Energy Industries							
Man. Industries and Construction							
Transport	Domestic Aviation						
	Road						
	Railways						
	National Navigation						
Other	Commercial/Institutional						
Sectors	Residential						
	Agriculture/Forestry/	Staionary					
	Fishing	Mobile					
Other(not elsewhere specified)							
Total			0	0	0	0	0
Memo:International Marine Bunkers							
Memo:International Aviation Bunkers							

MODULE	ENERGY
SUBMODULE	CO_2 From Fuel Combustion By Source Categories(Tier 1)
WORKSHEET	1-2 Overview
SHEET	7 of 10

			AE Municipal Solid Waste	AF Industrial Waste	AG	AH	AI
Fuel Consumption (TJ)							
Energy Industries							
Manufacturing Industries and Construction			64.995				
Transport	Domestic Aviation						
	Road						
	Railways						
	National Navigation						
Other	Commercial/Institutional						
Sectors	Residential						
	Agriculture/Forestry/	Stationary					
	Fishing	Mobile					
Other(not elsewhere specified)							
Total			64.995	0	0	0	0
Memo:International Marine Bunkers							
Memo:International Aviation Bunkers							
CO2 Emissions (Gg)							
Energy Industries							
Man. Industries and Construction			4.765823				
Transport	Domestic Aviation						
	Road						
	Railways						
	National Navigation						
Other	Commercial/Institutional						
Sectors	Residential						
	Agriculture/Forestry/	Staionary					
	Fishing	Mobile					
Other(not elsewhere specified)							
Total			4.765823	0	0	0	0
Memo:International Marine Bunkers							
Memo:International Aviation Bunkers							

MODULE	ENERGY
SUBMODULE	CO_2 From Fuel Combustion By Source Categories(Tier 1)
WORKSHEET	1-2 Overview
SHEET	8 of 10

			AJ	AK	AL Total Liquid Fossil	AM Total Solid Fossil	AN Total Gaseous Fossil
Fuel Consumption (TJ)							
Energy Industries					55252.1724	0	
Manufacturing Industries and Construction					34214.3641	5040	
Transport	Domestic Aviation				85.1669	0	
	Road				57450.04784	0	
	Railways				0	0	
	National Navigation				18.227036	0	
Other	Commercial/Institutional				3188.92441	0	
Sectors	Residential				8061.51177	0	
	Agriculture/Forestry/	Stationary			7798.8367	0	
	Fishing	Mobile			0	0	
Other(not elsewhere specified)					0	0	
Total			0	0	166069.2512	5040	0
Memo:International Marine Bunkers							
Memo:International Aviation Bunkers							
CO2 Emissions (Gg)							
Energy Industries					3903.9966	0	
Man. Industries and Construction					2416.993783	116.812	
Transport	Domestic Aviation				6.028539	0	
	Road				3949.83948	0	
	Railways				0	0	
	National Navigation				1.2564647	0	
Other	Commercial/Institutional				225.88433	0	
Sectors	Residential				530.957787	0	
	Agriculture/Forestry/	Staionary			571.8575	0	
	Fishing	Mobile			0	0	
Other(not elsewhere specified)					0	0	
Total			0	0	11606.81448	116.812	0
Memo:International Marine Bunkers							
Memo:International Aviation Bunkers							

MODULE	ENERGY
SUBMODULE	CO_2 From Fuel Combustion By Source Categories(Tier 1)
WORKSHEET	1-2 Overview
SHEET	9 of 10

			AO Total Other Fuels	AP Total	AQ Wood/Wood Waste	AR Charcoal	AS Other Solid Biomass
Fuel Consumption (TJ)							
Energy Industries							
Manufacturing Industries and Construction							
Transport	Domestic Aviation						
	Road						
	Railways						
	National Navigation						
Other	Commercial/Institutional						
Sectors	Residential					46.64	4784
	Agriculture/Forestry/	Stationary					
	Fishing	Mobile					
Other(not elsewhere specified)							
Total			0	0	0	46.64	4784
Memo:International Marine Bunkers							
Memo:International Aviation Bunkers							
CO2 Emissions (Gg)							
Energy Industries							
Man. Industries and Construction							
Transport	Domestic Aviation						
	Road						
	Railways						
	National Navigation						
Other	Commercial/Institutional						
Sectors	Residential					5.363438	550.0962
	Agriculture/Forestry/	Staionary					
	Fishing	Mobile					
Other(not elsewhere specified)							
Total			0	0	0	5.363438	550.0962
Memo:International Marine Bunkers							
Memo:International Aviation Bunkers							

MODULE	ENERGY
SUBMODULE	CO_2 From Fuel Combustion By Source Categories(Tier 1)
WORKSHEET	1-2 Overview
SHEET	10 of 10

			AT Liquid Biomass	AU Gaseous Biomass	AV Total Biomass
Fuel Consumption		(TJ)			
Energy Industries					
Manufacturing Industries and Construction					
Transport	Domestic Aviation				
	Road				
	Railways				
	National Navigation				
Other	Commercial/Institutional				
Sectors	Residential				4830.64
	Agriculture/Forestry/	Stationary			
	Fishing	Mobile			
Other(not elsewhere specified)					
Total			0	0	4830.64
Memo:International Marine Bunkers					
Memo:International Aviation Bunkers					
CO2 Emissions		(Gg)			
Energy Industries					
Man. Industries and Construction					
Transport	Domestic Aviation				
	Road				
	Railways				
	National Navigation				
Other	Commercial/Institutional				
Sectors	Residential				555.459638
	Agriculture/Forestry/	Staionary			
	Fishing	Mobile			
Other(not elsewhere specified)					
Total			0	0	555.459638
Memo:International Marine Bunkers					
Memo:International Aviation Bunkers					

MODULE	ENERGY
SUBMODULE	Non-CO_2 From Fuel Combustion By Source Categories(Tier 1)
WORKSHEET	1_3
SHEET	1 of 4 CH4

Activity		Step 1 A Fuel Consumption (Tj)					
		A1 Coal	A2 Natural Gas	A3 Oil	A4 Wood/Wood Waste	A5 Charcoal	A6 ther Biomass and Wastes
Energy Industries				56407.508			
Manufacturing Industries and Construction		5040		35729.475			
Transport	Domestic Aviation			85.1669			
	Road			57450.045			
	Railways						
	National Navigation			18.22705			
	Commercial/Institutional		689.78	2499.1444			
	Residential		5221.131	2840.38		46.64	4784
	Agriculture/ Stationary			7798.8367			
	Forestry/ Mobile						
	Fishing						
Other							
Total		5040	5910.911	162828.78		46.64	4784
Memo:International Marine Bunkers							
Memo:International Aviation Bunkers				6420.96			

MODULE	ENERGY
SUBMODULE	Non-CO_2 From Fuel Combustion By Source Categories(Tier 1)
WORKSHEET	1_3
SHEET	2 of 4 CH4

		Step 2					
		A Fuel Consumption (Tj)					
		A1	A2	A3	A4	A5	A6
s Activity		Coal	Natural Gas	Oil	Wood/Wood Waste	Charcoal	ther Biomass and Wastes
Energy Industries				3			
Manufacturing Industries and Construction		10	5	2			
Transport	Domestic Aviation			0.5			
	Road			20 / 5			
	Railways						
	National Navigation			5			
	Commercial/Institutional		5	10			
	Residential		5	10		200	
	Agriculture/ Stationary			10			
	Forestry/ Mobile						
	Fishing						
Other							
Total							
Memo:International Marine Bunkers							
Memo:International Aviation Bunkers				0.5			

MODULE	ENERGY
SUBMODULE	Non-CO_2 From Fuel Combustion By Source Categories(Tier 1)
WORKSHEET	1_3
SHEET	3 of 4 CH4

		Step 3				
			C Emissions by Fuel (Kg) C=(A*B)			
		B6	C1	C2	C3	C4
Activity		Other Biomass and Wastes	Coal	Natural Gas	Oil	Wood/Wood Waste
Energy Industries			0	0	169222.5234	0
Manufacturing Industries and Construction			50400	0	71458.94976	0
Transport	Domestic Aviation		0	0	42.58345	0
	Road		0	0	783517.02	0
	Railways		0	0	0	0
	National Navigation		0	0	91.13525	0
	Commercial/Institutional		0	3448.9	24991.4441	0
	Residential	300	0	26105.655	28403.8	0
	Agriculture/ Stationary		0	0	77988.367	0
	Forestry/ Mobile		0	0	0	0
	Fishing		0	0	0	0
Other			0	0	0	0
Total			50400	29554.555	1155715.823	0
Memo:International Marine Bunkers						
Memo:International Aviation Bunkers					3210.48	

MODULE	ENERGY
SUBMODULE	Non-CO_2 From Fuel Combustion By Source Categories(Tier 1)
WORKSHEET	1_3
SHEET	4 of 4 CH4

Activity		C5 Charcoal	C6 Other Biomass and Wastes	D Total Emissions (Gg) D=(sum C1...6)/10^6
Energy Industries		0	0	0.169222523
Manufacturing Industries and Construction		0	0	0.12185895
Transport	Domestic Aviation	0	0	4.25835E-05
	Road	0	0	0.78351702
	Railways	0	0	0
	National Navigation	0	0	9.11353E-05
	Commercial/Institutional	0	0	0.028440344
	Residential	9328	1435200	1.499037455
	Agriculture/ Stationary	0	0	0.077988367
	Forestry/ Mobile	0	0	0
	Fishing	0	0	0
Other		0	0	0
Total		0	0	1.235670378
		0	0	0
Memo:International Marine Bunkers				
Memo:International Aviation Bunkers				0.00321048

MODULE	ENERGY					
SUBMODULE	Non-CO_2 From Fuel Combustion By Source Categories(Tier 1)					
WORKSHEET	1_3					
SHEET	1of 4 N2O					
	Step 1					
	A					
	Fuel Consumption					
	(Tj)					
	A1	A2	A3	A4	A5	A6
Activity	Coal	Natural Gas	Oil	Wood/Wood Waste	Charcoal	ther Biomass and Wastes
Energy Industries			56407.508			
Manufacturing Industries and Construction	5040		35729.475			
Transport Domestic Aviation			85.1669			
Road			57450.045			
Railways						
National Navigation			18.22705			
Commercial/Institutional		689.78	2499.1444			
Residential		5221.131	2840.38		46.64	4784
Agriculture/ Stationary			7798.8367			
Forestry/ Mobile						
Fishing						
Other						
Total	5040	5910.911	162828.78		46.64	4784
Memo:International Marine Bunkers						
Memo:International Aviation Bunkers			6420.96			

MODULE	ENERGY
SUBMODULE	Non-CO_2 From Fuel Combustion By Source Categories(Tier 1)
WORKSHEET	1_3
SHEET	2 of 4 N2O

Step 2

s	Activity	B Emission Factors (Kg/Tj)					
		B1 Coal	B2 Natural Gas	B3 Oil	B4 Wood/Wood Waste	B5 Charcoal	B6 ther Biomass and Wastes
Energy Industries				0.6			
Manufacturing Industries and Construction		1.4	0.1	0.6			
Transport	Domestic Aviation			2			
	Road			0.6 /0.6			
	Railways						
	National Navigation			0.6			
	Commercial/Institutional		0.1	0.6			
	Residential		0.1	0.6		1	4
	Agriculture/ Stationary			0.6			
	Forestry/ Mobile						
	Fishing						
Other							
Total							
Memo:International Marine Bunkers							
Memo:International Aviation Bunkers				2			

MODULE	ENERGY
SUBMODULE	Non-CO_2 From Fuel Combustion By Source Categories(Tier 1)
WORKSHEET	1_3
SHEET	3 of 4 N2O

		Step 3 .				
		C				
		Emissions by Fuel				
		(Kg)				
		C=(A*B)				
		C1	C2	C3	C4	C5
Activity		Coal	Natural Gas	Oil	Wood/Wood Waste	Charcoal
Energy Industries		0	0	33844.50468	0	0
Manufacturing Industries and Construction		7056	0	21437.68493	0	0
Transport	Domestic Aviation	0	0	170.3338	0	0
	Road	0	0	24303.11579	0	0
	Railways	0	0	0	0	0
	National Navigation	0	0	10.93623	0	0
	Commercial/Institutional	0	68.978	1499.486646	0	0
	Residential	0	522.1131	1704.228	0	46.64
	Agriculture/ Stationary	0	0	4679.30202	0	0
	Forestry/ Mobile	0	0	0	0	0
	Fishing	0	0	0	0	0
Other		0	0	0	0	0
Total		7056	591.0911	87649.59209	0	46.64
Memo:International Marine Bunkers						
Memo:International Aviation Bunkers				12841.92		

MODULE	ENERGY	
SUBMODULE	Non-CO_2 From Fuel Combustion By Source Categories(Tier 1)	
WORKSHEET	1_3	
SHEET	4 of 4	N2O

Activity		C6 Other Biomass and Wastes	D Total Emissions (Gg) $D=(sum\ C1...6)/10^6$
Energy Industries		0	0.033844505
Manufacturing Industries and Construction		0	0.028493685
Transport	Domestic Aviation	0	0.000170334
	Road	0	0.024303116
	Railways	0	0
	National Navigation	0	1.09362E-05
	Commercial/Institutional	0	0.001568465
	Residential	19136	0.021408981
	Agriculture/ Stationary	0	0.004679302
	Forestry/ Mobile	0	0
	Fishing	0	0
Other		0	0
Total		0	0.095343323
		0	0
Memo:International Marine Bunkers			
Memo:International Aviation Bunkers			0.01284192

MODULE	ENERGY
SUBMODULE	Non-CO_2 From Fuel Combustion By Source Categories(Tier 1)
WORKSHEET	1_3
SHEET	1 of 4 Nox

Step 1							
		A Fuel Consumption (Tj)					
		A1	A2	A3	A4	A5	A6
Activity		Coal	Natural Gas	Oil	Wood/Wood Waste	Charcoal	ther Biomass and Wastes
Energy Industries				56407.508			
Manufacturing Industries and Construction		5040		35729.475			
Transport	Domestic Aviation			85.1669			
	Road			57450.045			
	Railways						
	National Navigation			18.22705			
	Commercial/Institutional		689.78	2499.1444			
	Residential		5221.131	2840.38		46.64	4784
	Agriculture/ Stationary			7798.8367			
	Forestry/ Mobile						
	Fishing						
Other							
Total		5040	5910.911	162828.78		46.64	4784
Memo:International Marine Bunkers							
Memo:International Aviation Bunkers				6420.96			

MODULE	ENERGY
SUBMODULE	Non-CO_2 From Fuel Combustion By Source Categories(Tier 1)
WORKSHEET	1_3
SHEET	2 of 4 Nox

		Step 2					
		B Emission Factors (Kg/Tj)					
		B1	B2	B3	B4	B5	B6
s	Activity	Coal	Natural Gas	Oil	Wood/Wood Waste	Charcoal	ther Biomass and Wastes
Energy Industries				200			
Manufacturing Industries and Construction		300	150	200			
Transport	Domestic Aviation			300			
	Road			600 / 800			
	Railways						
	National Navigation			1500			
	Commercial/Institutional		50	100			
	Residential		50	100		100	100
	Agriculture/ Stationary			100			
	Forestry/ Mobile						
	Fishing						
Other							
Total							
Memo:International Marine Bunkers							
Memo:International Aviation Bunkers				300			

MODULE	ENERGY
SUBMODULE	Non-CO_2 From Fuel Combustion By Source Categories(Tier 1)
WORKSHEET	1_3
SHEET	3 of 4 Nox

		Step 3				
		C				
		Emissions by Fuel				
		(Kg)				
		C=(A*B)				
		C1	C2	C3	C4	C5
Activity		Coal	Natural Gas	Oil	Wood/Wood Waste	Charcoal
Energy Industries		0	0	11281501.56	0	0
Manufacturing Industries and Construction		1512000	0	7145894.976	0	0
Transport	Domestic Aviation	0	0	25550.07	0	0
	Road	0	0	24657609.6	0	0
	Railways	0	0	0	0	0
	National Navigation	0	0	27340.575	0	0
	Commercial/Institutional	0	34489	249914.441	0	0
	Residential	0	261056.55	284038	0	4664
	Agriculture/ Stationary	0	0	779883.67	0	0
	Forestry/ Mobile	0	0	0	0	0
	Fishing	0	0	0	0	0
Other		0	0	0	0	0
Total		1512000	295545.55	44451732.89	0	4664
Memo:International Marine Bunkers						
Memo:International Aviation Bunkers				1926288		

MODULE	ENERGY	
SUBMODULE	Non-CO_2 From Fuel Combustion By Source Categories(Tier 1)	
WORKSHEET	1_3	
SHEET	4 of 4	Nox

Activity			C6 Other Biomass and Wastes	D Total Emissions (Gg) D=(sum C1...6)/10^6
Energy Industries			0	11.28150156
Manufacturing Industries and Construction			0	8.657894976
Transport	Domestic Aviation		0	0.02555007
	Road		0	24.6576096
	Railways		0	0
	National Navigation		0	0.027340575
	Commercial/Institutional		0	0.284403441
	Residential		478400	1.02815855
	Agriculture/	Stationary	0	0.77988367
	Forestry/	Mobile	0	0
	Fishing		0	0
Other			0	0
Total			0	46.26394244
			0	0
Memo:International Marine Bunkers				
Memo:International Aviation Bunkers				1.926288

MODULE	ENERGY					
SUBMODULE	Non-CO_2 From Fuel Combustion By Source Categories(Tier 1)					
WORKSHEET	1_3					
SHEET	1of 4 CO					
	Step 1					
	A					
	Fuel Consumption					
	(Tj)					
	A1	A2	A3	A4	A5	A6
Activity	Coal	Natural Gas	Oil	Wood/Wood Waste	Charcoal	ther Biomass and Wastes
Energy Industries			56407.508			
Manufacturing Industries and Construction	5040		35729.475			
Transport Domestic Aviation			85.1669			
Road			57450.045			
Railways						
National Navigation			18.22705			
Commercial/Institutional		689.78	2499.1444			
Residential		5221.131	2840.38		46.64	4784
Agriculture/ Stationary			7798.8367			
Forestry/ Mobile						
Fishing						
Other						
Total	5040	5910.911	162828.78		46.64	4784
Memo:International Marine Bunkers						
Memo:International Aviation Bunkers			6420.96			

MODULE	ENERGY
SUBMODULE	Non-CO_2 From Fuel Combustion By Source Categories(Tier 1)
WORKSHEET	1_3
SHEET	2of 4 CO

		Step 2					
		B Emission Factors (Kg/Tj)					
		B1	B2	B3	B4	B5	B6
s	Activity	Coal	Natural Gas	Oil	Wood/Wood Waste	Charcoal	ther Biomass and Wastes
Energy Industries				15			
Manufacturing Industries and Construction		150	30	10			
Transport	Domestic Aviation			100			
	Road			8000/ 1000			
	Railways						
	National Navigation			1000			
	Commercial/Institutional		50	20			
	Residential		50	20		7000	5000
	Agriculture/ Stationary			20			
	Forestry/ Mobile						
	Fishing						
Other							
Total							
Memo:International Marine Bunkers							
Memo:International Aviation Bunkers				100			

MODULE	ENERGY
SUBMODULE	Non-CO_2 From Fuel Combustion By Source Categories(Tier 1)
WORKSHEET	1_3
SHEET	3 of 4 CO

Activity		C2 Natural Gas	C3 Oil	C4 Wood/Wood Waste	C5 Charcoal	C6 ther Biomass and Wastes
Energy Industries		0	846112.617	0	0	0
Manufacturing Industries and Construction		0	357294.7488	0	0	0
Transport	Domestic Aviation	0	8516.69	0	0	0
	Road	0	311634348	0	0	0
	Railways	0	0	0	0	0
	National Navigation	0	18227.05	0	0	0
	Commercial/Institutional	34489	49982.8882	0	0	0
	Residential	261056.55	56807.6	0	326480	23920000
	Agriculture/ Stationary	0	155976.734	0	0	0
	Forestry/ Mobile	0	0	0	0	0
	Fishing	0	0	0	0	0
Other		0	0	0	0	0
Total		295545.55	313127266.3	0	326480	23920000
Memo:International Marine Bunkers						
Memo:International Aviation Bunkers			642096			

MODULE	ENERGY	
SUBMODULE	Non-CO_2 From Fuel Combustion By Source Categories(Tier 1)	
WORKSHEET	1_3	
SHEET	4 of 4	CO
		D Total Emissions (Gg) D=(sum C1...6)/10^6
s Activity		
Energy Industries		311.634348
Manufacturing Industries and Construction		0
Transport	Domestic Aviation	0.01822705
	Road	0.049982888
	Railways	24.3032876
	National Navigation	0.155976734
	Commercial/Institutional	0
	Residential	0
	Agriculture/ Stationary	0
	Forestry/ Mobile	337.3737463
	Fishing	0
Other		0
Total		0.642096
		0
Memo:International Marine Bunkers		
Memo:International Aviation Bunkers		0

MODULE	ENERGY						
SUBMODULE	Non-CO_2 From Fuel Combustion By Source Categories(Tier 1)						
WORKSHEET	1_3						
SHEET	1 of 4 VMVOC						
	Step 1						
	A Fuel Consumption (Tj)						
Activity	A1 Coal	A2 Natural Gas	A3 Oil	A4 Wood/Wood Waste	A5 Charcoal	A6 ther Biomass and Wastes	
Energy Industries			56407.508				
Manufacturing Industries and Construction	5040		35729.475				
Transport Domestic Aviation			85.1669				
Road			57450.045				
Railways							
National Navigation			18.22705				
Commercial/Institutional		689.78	2499.1444				
Residential		5221.131	2840.38		46.64	4784	
Agriculture/ Stationary			7798.8367				
Forestry/ Mobile							
Fishing							
Other							
Total	5040	5910.911	162828.78		46.64	4784	
Memo:International Marine Bunkers							
Memo:International Aviation Bunkers			6420.96				

MODULE	ENERGY
SUBMODULE	Non-CO_2 From Fuel Combustion By Source Categories(Tier 1)
WORKSHEET	1_3
SHEET	2 of 4 VMVOC

		Step 2					
		B Emission Factors (Kg/Tj)					
		B1	B2	B3	B4	B5	B6
s	Activity	Coal	Natural Gas	Oil	Wood/Wood Waste	Charcoal	ther Biomass and Wastes
Energy Industries				5			
Manufacturing Industries and Construction		20	5	5			
Transport	Domestic Aviation			50			
	Road			1500 / 200			
	Railways						
	National Navigation			200			
	Commercial/Institutional		5	5			
	Residential		5	5		100	600
	Agriculture/ Stationary			5			
	Forestry/ Mobile						
	Fishing						
Other							
Total							
Memo:International Marine Bunkers							
Memo:International Aviation Bunkers				50			

MODULE	ENERGY
SUBMODULE	Non-CO_2 From Fuel Combustion By Source Categories(Tier 1)
WORKSHEET	1_3
SHEET	3 of 4 VMVOC

		Step 3				
		C				
		Emissions by Fuel				
		(Kg)				
		C=(A*B)				
		C1	C2	C3	C4	C5
Activity		Coal	Natural Gas	Oil	Wood/Wood Waste	Charcoal
Energy Industries		0	0	282037.539	0	0
Manufacturing Industries and Construction		100800	0	178647.3744	0	0
Transport	Domestic Aviation	0	0	4258.345	0	0
	Road	0	0	58453596	0	0
	Railways	0	0	0	0	0
	National Navigation	0	0	3645.41	0	0
	Commercial/Institutional	0	3448.9	12495.72205	0	0
	Residential	0	26105.655	14201.9	0	4664
	Agriculture/ Stationary	0	0	38994.1835	0	0
	Forestry/ Mobile	0	0	0	0	0
	Fishing	0	0	0	0	0
Other		0	0	0	0	0
Total		100800	29554.555	58987876.47	0	4664
Memo:International Marine Bunkers						
Memo:International Aviation Bunkers				321048		

MODULE	ENERGY	
SUBMODULE	Non-CO_2 From Fuel Combustion By Source Categories(Tier 1)	
WORKSHEET	1_3	
SHEET	4 of 4	VMVOC
		D Total Emissions (Gg) D=(sum C1...6)/10^6
	C6	
Activity	Other Biomass and Wastes	
Energy Industries	0	0.282037539
Manufacturing Industries and Construction	0	0.279447374
Transport Domestic Aviation	0	0.004258345
Road	0	58.453596
Railways	0	0
National Navigation	0	0.00364541
Commercial/Institutional	0	0.015944622
Residential	2870400	2.915371555
Agriculture/ Stationary	0	0.038994184
Forestry/ Mobile	0	0
Fishing	0	0
Other	0	0
Total	0	59.12289503
	0	0
Memo:International Marine Bunkers		
Memo:International Aviation Bunkers		0.321048

MODULE	ENERGY
SUBMODULE	SO_2 From Fuel Combustion By Source Categories(Tier 1)
WORKSHEET	1_4
SHEET	1of 1Sector

Energy Industry		A Fuel Consumption (Tj)	B Sulphur Content of Fuel (%)	C Sulphur retention in ash (%)	D Abatement Efficiency (%)	E Net Calorific Value (Tj/kt)	F SO2 Emission factor (Kg/Tj)	G Emissions (t)
Fuel Type								G=(A*F)/1000
Coal	low							
	medium		1.5	5	1	28	1007.678571	0
	high							
Heavy Fuel Oil	low							
	medium	45176.3733	2	1	1	40.19	975.466534	44068.04028
	high							
Light Fuel Oil/	low							
diesel	high	2108	1	1	1	43.33	452.3886453	953.6352643
Diesel(road)			0.3	1	1	43.33	135.7165936	
Gasoline(road)			0.1	1	1	44.8	43.75446429	
Jet Kerosene			0.05	1	1	44.59	21.98026463	
Oil Shale								
Other Oil								
Natural Gas								
Municipal Waste			0.003	1	1			
Industrial Waste								
Black Liquor								
Fuelwood			0.2	1	1			
Other Biomass								
Total		47284.3733						45021.67554
Memo: Fuels for International Marine Bunkers								
Memo: Fuels for International Aviation Bunkers			0.05	1	1			

MODULE	ENERGY
SUBMODULE	SO_2 From Fuel Combustion By Source Categories(Tier 1)
WORKSHEET	1_4
SHEET	1of 1Sector

manufacturing industries and construction		A Fuel Consumption (Tj)	B Sulphur Content of Fuel (%)	C Sulphur retention in ash (%)	D Abatement Efficiency (%)	E Net Calorific Value (Tj/kt)	F SO2 Emission factor (Kg/Tj)	G Emissions (t)
Fuel Type							F=2*(B/100)*(1/E)*(100-C	G=(A*F)/1000
Coal	low							
	medium	5040	1.5	5	1	28	1007.678571	5078.7
	high							
Heavy Fuel Oil	low							
	medium	11532.279	2	1	1	40.19	975.466534	11249.35222
	high							
Light Fuel Oil/	low							
diesel	high	18433.6219	1	1	1	43.33	452.3886453	8339.161239
Diesel(road)			0.3	1	1	43.33	135.7165936	
Gasoline(road)			0.1	1	1	44.8	43.75446429	
Jet Kerosene			0.05	1	1	44.59	21.98026463	
Oil Shale								
Other Oil								
Natural Gas								
Municipal Waste		64.995	0.003	1	1	43.33	1.357165936	0.088209
Industrial Waste								
Black Liquor								
Fuelwood			0.2	1	1	15	261.36	
Other Biomass			1.5	1	1	30	980.1	
Total		35070.8959						24667.30167
Memo: Fuels for International Marine Bunkers								
Memo: Fuels for International Aviation Bunkers			0.05	1	1			

MODULE	ENERGY
SUBMODULE	SO_2 From Fuel Combustion By Source Categories(Tier 1)
WORKSHEET	1_4
SHEET	1of 1Sector

Transport		A Fuel Consumption (Tj)	B Sulphur Content of Fuel (%)	C Sulphur retention in ash (%)	D Abatement Efficiency (%)	E Net Calorific Value (Tj/kt)	F SO2 Emission factor (Kg/Tj)	G Emissions (t)
Fuel Type							F=2*(B/100)*(1/E)*(100-C	G=(A*F)/1000
Coal	low							
	medium		1.5	5	1	28	1007.678571	0
	high							
Heavy Fuel Oil	low							
	medium		2	1	1	40.19	975.466534	0
	high							
Light Fuel Oil/	low							
diesel	high		1	1	1	43.33	452.3886453	0
Diesel(road)		1772.45698	0.3	1	1	43.33	135.7165936	240.5518236
Gasoline(road)		55677.5878	0.1	1	1	44.8	43.75446429	2436.143029
Jet Kerosene		85.1669	0.05	1	1	44.59	21.98026463	1.871991
Oil Shale								
Other Oil								
Natural Gas								
Municipal Waste			0.003	1	1			
Industrial Waste								
Black Liquor								
Fuelwood			0.2	1	1			
Other Biomass								
Total		57535.2117						2678.566843
Memo: Fuels for International Marine Bunkers								
Memo: Fuels for International Aviation Bunkers		6420.96	0.05	1	1	44.59	21.98026463	141.1344

MODULE	ENERGY
SUBMODULE	SO_2 From Fuel Combustion By Source Categories(Tier 1)
WORKSHEET	1_4
SHEET	1of 1Sector

Commercial/ Institutional		A Fuel Consumption (Tj)	B Sulphur Content of Fuel (%)	C Sulphur retention in ash (%)	D Abatement Efficiency (%)	E Net Calorific Value (Tj/kt)	F SO2 Emission factor (Kg/Tj)	G Emissions (t)
Fuel Type							F=2*(B/100)*(1/E)*(100-C	G=(A*F)/1000
Coal	low							
	medium		1.5	5	1	28	1007.678571	
	high							
Heavy Fuel Oil	low							
	medium		2	1	1	40.19	975.466534	
	high							
Light Fuel Oil/	low							
diesel	high	2499.14441	1	1	1	43.33	452.3886453	1130.584554
Diesel(road)			0.3	1	1	43.33	135.7165936	
Gasoline(road)			0.1	1	1	44.8	43.75446429	
Jet Kerosene			0.05	1	1	44.59	21.98026463	
Oil Shale								
Other Oil								
Natural Gas								
Municipal Waste			0.003	1	1			
Industrial Waste								
Black Liquor								
Fuelwood			0.2	1	1			
Other Biomass								
Total		2499.14441						1130.584554
Memo: Fuels for International Marine Bunkers								
Memo: Fuels for International Aviation Bunkers			0.05	1	1			

MODULE	ENERGY
SUBMODULE	SO_2 From Fuel Combustion By Source Categories(Tier 1)
WORKSHEET	1_4
SHEET	1of 1Sector

Residential		A Fuel Consumption (Tj)	B Sulphur Content of Fuel (%)	C Sulphur retention in ash (%)	D Abatement Efficiency (%)	E Net Calorific Value (Tj/kt)	F SO2 Emission factor (Kg/Tj)	G Emissions (t)
Fuel Type							F=2*(B/100)*(1/E)*(100-C	G=(A*F)/1000
Coal	low							
	medium		1.5	5	1	28	1007.678571	
	high							
Heavy Fuel Oil	low							
	medium		2	1	1	40.19	975.466534	
	high							
Light Fuel Oil/	low							
diesel	high	2835.90517	1	1	1	43.33	452.3886453	1282.931298
Diesel(road)			0.3	1	1	43.33	135.7165936	
Gasoline(road)			0.1	1	1	44.8	43.75446429	
Jet Kerosene			0.05	1	1	44.59	21.98026463	
Oil Shale								
(Other Oil)	(kerosene)	4.475	0.05	1	1	44.75	21.90167598	0.09801
Natural Gas								
Municipal Waste			0.003	1	1			
Industrial Waste								
Black Liquor								
Fuelwood		4784	0.2	1	1	15	261.36	1250.34624
Other Biomass	(chracoal)	46.64	1.5	1	1	30	980.1	45.711864
Total		7671.02017						2579.087412
Memo: Fuels for International Marine Bunkers								
Memo: Fuels for International Aviation Bunkers			0.005	1	1			

MODULE	ENERGY
SUBMODULE	SO_2 From Fuel Combustion By Source Categories(Tier 1)
WORKSHEET	1_4
SHEET	1of 1Sector

Agriculture/forestry/ fishing		A Fuel Consumption (Tj)	B Sulphur Content of Fuel (%)	C Sulphur retention in ash (%)	D Abatement Efficiency (%)	E Net Calorific Value (Tj/kt)	F SO2 Emission factor (Kg/Tj)	G Emissions (t)
Fuel Type							F=2*(B/100)*(1/E)*(100-D	G=(A*F)/1000
Coal	low							
	medium		1.5	5	1	28	1007.678571	
	high							
Heavy Fuel Oil	low							
	medium		2	1	1	40.19	975.466534	
	high							
Light Fuel Oil/	low							
diesel	high	7798.8367	1	1	1	43.33	452.3886453	3528.105169
Diesel(road)			0.3	1	1	43.33	135.7165936	
Gasoline(road)			0.1	1	1	44.8	43.75446429	
Jet Kerosene			0.05	1	1	44.59	21.98026463	
Oil Shale								
Other Oil								
Natural Gas								
Municipal Waste			0.003	1	1			
Industrial Waste								
Black Liquor								
Fuelwood			0.2	1	1			
Other Biomass								
Total		7798.8367						3528.105169
Memo: Fuels for International Marine Bunkers								
Memo: Fuels for International Aviation Bunkers			0.005	1	1			

APPENDIX 2
INDUSTRIAL PROCESSES IPCC WORKSHEETS

MODULE	INDUSTRIAL PROCESSES		
SUBMODULE	CEMENT PRODUCTION		
WORKSHEET	2-1		
SHEET	1 OF 2 CO_2 Emissions		
	STEP I		
A	B	C	D
Quantity of Cement Produced (t)	Emission Factor (t CO_2/t cement produced)	CO_2 Emitted (t) C = (A x B)	CO_2 Emitted (Gg) D = C/10^3
2980000	0.4985	1485530	1485.53

MODULE	INDUSTRIAL PROCESSES		
SUBMODULE	CEMENT PRODUCTION		
WORKSHEET	2-1		
SHEET	2 OF 2 SO_2 Emissions		
	STEP 2		
A	B	C	D
Quantity of Cemen Produced (t)	Emission Factor (kg SO_2/t Cement produced)	SO_2 Emitted (kg) C = (A x B)	SO_2 Emitted (Gg) D = C/10^6
2980000	0.3	894000	0.894

MODULE	INDUSTRIAL PROCESSES
SUBMODULE	PRODUCTION OF LIME
WORKSHEET	2-2
SHEET	1 OF 1 CO2 EMISSIONS

Lime Type	A Quantity of Lime Produced (t)	B Emission Factor (t CO2/t quicklime or dolomite lime produced)	C CO_2 Emitted (t)	D CO_2 Emitted (Gg)
			C = (A x B)	D = C/10^3
Quick Lime	20773	0.79	16410.67	16.41067
Dolmitic Lime	NO	0.91	0	0
			Total(Gg):	16.41067

MODULE	INDUSTRIAL PROCESSES
SUBMODULE	LIMESTONE AND DOLOMITE USE
WORKSHEET	2-3
SHEET	1 OF 1 CO2 EMISSIONS

Lime Type	A Quantity of Limestone or Dolomite Used (t)	B Emission Factor (t CO2/t limestone or dolomite Used)	C CO_2 Emitted (t)	D CO_2 Emitted (Gg)
			C = (A x B)	D = C/10^6
Limestone	0	440	0	0
Dolmite	NO	477	0	0
			Total(Gg):	0

MODULE	INDUSTRIAL PROCESSES		
SUBMODULE	SODA ASH PRODUCTION AND USE		
WORKSHEET	2-4		
SHEET	1 OF 2 SODA ASH PRODUCTION- CO_2 - EMISSIONS		
	STEP 1		
A Quantity of Trona Utilised (t)	B Emission Factor (t CO_2/t trona utilised	C CO_2 Emitted (t)	D CO_2 Emitted (Gg)
		C = (A x B)	$D = C/10^3$
0	0.097	0	0

MODULE	INDUSTRIAL PROCESSES		
SUBMODULE	SODA ASH PRODUCTION AND USE		
WORKSHEET	2-4		
SHEET	2 OF 2 SODA ASH USE - CO_2 - EMISSIONS		
	STEP 1		
A Quantity of Soda Ash used (t)	B Emission Factor (kg CO_2/t Soda Ash used)	C CO_2 Emitted (kg)	D CO_2 Emitted (Gg)
		C = (A x B)	$D = C/10^6$
12072.6	415	5010129	5.010129

MODULE	INDUSTRIAL PROCESSES
SUBMODULE	PRODUCTION AND USE OF MISCILLANEOUS MINERAL PRODUCTS
WORKSHEET	2-5
SHEET	1 OF 5 ASPHALT ROOFING PRODUCTION- NMVOC - EMISSIONS

STEP 1

Process Type	A Quantity of Asphelt Roofing Produced (t)	B Emission Factor (kg NMVOC/t asphelt roofing produced)	C NMVOC Emitted (kg)	D NMVOC Emitted (Gg)
			C = (A x B)	D = C/10^6
Saturation Process	0	0.16	0	0
Blowing Process	40,414	2.4	96993.6	0.0969936
			Total (Gg):	0.0969936

MODULE	INDUSTRIAL PROCESSES
SUBMODULE	PRODUCTION AND USE OF MISCELLANEOUS MINERAL PRODUCTS
WORKSHEET	2-5
SHEET	2 OF 5 ASPHALT ROOFING PRODUCTION - CO - EMISSIONS

STEP 2

A Quantity of Asphelt Roofing Produced (t)	B Emission Factor (kg CO2/t asphelt roofing produced)	C CO Emitted (kg)	D CO Emitted (Gg)
		C = (A x B)	D = C/10^6
40414	0.0095	383.933	0.000383933

MODULE	INDUSTRIAL PROCESSES
SUBMODULE	PRODUCTION AND USE OF MISCELLANEOUS MINERAL PRODUCTS
WORKSHEET	2 - 5
SHEET	3 OF 5 ROAD PAVING WITH ASPHALT - NMVOC - EMISSIONS

STEP 3

Emission Source	A Quantity of Road Paving Material Used (t)	B Emission Factor (kg NMVOC/t road paving material used)	C NMVOC Emitted (kg)	D NMVOC Emitted (Gg)
			C = (A x B)	D = C/10^6
Asphalt Plant	218944	0.023	5035.712	0.005
Road Surface	218944	320	70062080	70.062
			Total (Gg):	70.067

MODULE	INDUSTRIAL PROCESSES
SUBMODULE	PRODUCTION AND USE OF MISCELLANEOUS MINERAL PRODUCTS
WORKSHEET	2-5
SHEET	4 OF 5 PRODUCTION OF OTHER MINERAL PRODUCTS - GLASS PRODUCTION -
	NMVOC EMISSIONS

STEP 4

Glass Type	A Quantity of Glass Produced (t)	B Emission Factor (kg NMVOC/t Glass Produced)	C NMVOC Emitted (kg)	D NMVOC Emitted (Gg)
			C = (A x B)	D = C/10^6
Container Glass	56030	4.5	252135	0.252135
Flat Glass	15000	4.5	67500	0.0675
			Total (Gg):	0.319635

MODULE	INDUSTRIAL PROCESSES
SUBMODULE	PRODUCTION AND USE OF MISCELLANEOUS MINERAL PRODUCTS
WORKSHEET	2-5
SHEET	5 OF 5 PRODUCTION of OTHER MINERAL PRODUCTS - CONCRETE
	PUMIC STONE - SO_2 EMISSIONS

STEP 5

A Quantity of Concrete Pumic Stone Produced (t)	B Emission Factor (kg SO_2/t Concrete pumic stoneproduced)	C SO_2 Emitted (kg)	D SO_2 Emitted (Gg)
		C = (A x B)	D = C/10^6
0	0.5	0	0

MODULE	INDUSTRIAL PROCESSES			
SUBMODULE	AMMONIA PRODUCTION			
WORKSHEET	2-6			
SHEET	1 OF 3 TIER 1A - CO_2 EMISSIONS			
	STEP 1			
A Amount of Gas Consumed m3	B Carbon Content of Gas kg/m3	C Conversion Ratio	D CO_2 Emitted (kg)	E CO_2 Emitted (Gg)
		44/12	D = (A x B x C)	E = C/10^6
NO				

MODULE	INDUSTRIAL PROCESSES		
SUBMODULE	AMMONIA PRODUCTION		
WORKSHEET	2-6		
SHEET	2 OF 3 TIER 1b - CO_2 EMISSIONS		
	STEP 2		
A Amount of Ammonia Produced (t)	B Emission Factor (t CO_2/t ammonia produced)	C CO_2 Emitted (t)	D CO_2 Emitted (Gg)
		C = (A x B)	D = C/10^3
0	1.5	0	0

MODULE	INDUSTRIAL PROCESSES		
SUBMODULE	AMMONIA PRODUCTION		
WORKSHEET	2-6		
SHEET	3 OF 3 NMVOC, CO AND SO_2 EMISSIONS		
	STEP 3		
A Amount of Ammonia Produced (t)	B Emission Factor (kg Pollutant/t ammonia produced)	C Pollutant Emitted (t)	D Pollutant Emitted (Gg)
		C = (A x B)	D = C/10^6
0	NMVOC 4.7	0	NMVOC 0
0	CO 7.9	0	CO 0
0	SO_2 0.03	0	SO_2 0

MODULE	INDUSTRIAL PROCESSES
SUBMODULE	NITRIC ACID PRODUCTION
WORKSHEET	2-7
SHEET	1 OF 1 N_2O AND Nox EMISSIONS

STEP 1			
A Amount of Nitric Acid Produced (t)	B Emission Factor (kg Pollutant/t nitric acid produced)	C Pollutant Emitted (t)	D Pollutant Emitted (Gg)
		C = (A x B)	D = C/10^3
0	N_2O 5	0	N_2O 0
0	Nox 1	0	Nox 0

MODULE	INDUSTRIAL PROCESSES
SUBMODULE	ADIPIC ACID PRODUCTION
WORKSHEET	2-8
SHEET	1 OF 1 N_2O, Nox, NMVOC & CO EMISSIONS

STEP 1			
A Amount of Adipic Acid Produced (t)	B Emission Factor (kg Pollutant/t adipic acid produced)	C Pollutant Emitted (t)	D Pollutant Emitted (Gg)
		C = (A x B)	D = C/10^3
0	N2O 300	0	N2O
0	Nox 8.1	0	Nox
0	NMVOC 43.3	0	NMVOC
0	CO 34.4	0	CO

MODULE	INDUSTRIAL PROCESSES			
SUBMODULE	CARBIDE PRODUCTION			
WORKSHEET	2-9			
SHEET	1 OF 4 SILICON CARBIDE PRODUCTION - CO_2 EMISSIONS			
STEP 1				
A Consumption Of Coke (t)	B Carbon Content in Coke (%)	C Conversion Ratio (%)	D CO_2 Emitted (t)	E CO_2 Emitted (Gg)
			D = A x B (100 - C) x 3.67 x 10E-4	E = C/10^3
0	97	35	0	0

MODULE	INDUSTRIAL PROCESSES		
SUBMODULE	CARBIDE PRODUCTION		
WORKSHEET	2- 9		
SHEET	2 OF 4 SILICON CARBIDE PRODUCTION - TIER 1a - CH4 EMISSIONS		
STEP 1			
A Amount of Petrol Coke Consumed (t)	B Emission Factor (kg CH_4/t petrol coke consumed)	C CH_4 Emitted (kg)	D CH_4 Emitted (Gg)
		C = (A x B)	D = C/10^6
0	10.2	0	0

MODULE	INDUSTRIAL PROCESSES		
SUBMODULE	CARBIDE PRODUCTION		
WORKSHEET	2- 9		
SHEET	3 OF 4 SILICON CARBIDE PRODUCTION - TIER 1b - CH4 EMISSIONS		
STEP 1			
A Amount of Silicon Carbide Produced (t)	B Emission Factor (kg CH4/t silicon carbide produced)	C CH4 Emitted (kg)	D CH4 Emitted (Gg)
		C = (A x B)	D = C/10E6
0	11.6	0	0

MODULE	INDUSTRIAL PROCESSES		
SUBMODULE	CARBIDE PRODUCTION		
WORKSHEET	2- 9		
SHEET	4 OF 4 CALCIUM CARBIDE PRODUCTION - CO2 EMISSIONS		
STEP 1			
A Amount of Carbide Produced (t)	B Emission Factor (kg CH4/t carbide produced)	C CO2 Emitted (t)	D CO2 Emitted (Gg)
		C = (A x B)	D = C/10E3
0	1.1	0	0
		Total (Gg) :	0

MODULE	INDUSTRIAL PROCESSES
SUBMODULE	PRODUCTION OF OTHER CHEMICALS
WORKSHEET	2 - 10
SHEET	1 OF 5 CH_4 EMISSIONS

STEP 1

Chemical	A Amount of Chemical Produced (t)	B Emission Factor (kg CH_4/t chemical produced)	C CH_4 Emitted (kg)	D CH_4 Emitted (Gg)
			C = (A x B)	D = C/10^6
Carbon black	0	11	0	0
Ethylene	0	1	0	0
Dichloroetheylene	0	0.4	0	0
Styrene	0	4	0	0
Methanol	0	2	0	0
Coke	0	0.5	0	0
			Total (Gg) :	0

MODULE	INDUSTRIAL PROCESSES
SUBMODULE	PRODUCTION OF OTHER CHEMICALS
WORKSHEET	2 - 10
SHEET	2 OF 5 NOx EMISSIONS

STEP 2

Chemical	A Amount of Chemical Produced (t)	B Emission Factor (kg NOx/t chemical produced)	C NOx Emitted (kg)	D NOx Emitted (Gg)
			C = (A x B)	D = C/10^6
Carbon black	0	0.4	0	0
			Total (Gg) :	0

MODULE	INDUSTRIAL PROCESSES			
SUBMODULE	PRODUCTION OF OTHER CHEMICALS			
WORKSHEET	2 - 10			
SHEET	3 OF 5 NMVOC EMISSIONS			
	STEP 2			
Chemical	A Amount of Chemical Produced (t)	B Emission Factor (kg NMVOC/t chemical produced)	C NMVOC Emitted (kg)	D NMVOC Emitted (Gg)
			C = (A x B)	D = C/10^6
Carbon black	0	40	0	0
Ethylene	0	1.4		
Dichloroetheylene	0	2.2		
Styrene	0	18		
			Total (Gg) :	

MODULE	INDUSTRIAL PROCESSES			
SUBMODULE	PRODUCTION OF OTHER CHEMICALS			
WORKSHEET	2 - 10			
SHEET	4 OF 5 CO EMISSIONS			
	STEP 2			
Chemical	A Amount of Chemical Produced (t)	B Emission Factor (kg CO/t chemical produced)	C CO Emitted (kg)	D CO Emitted (Gg)
			C = (A x B)	D = C/10^6
Carbon black	0	10	0	0
			Total (Gg) :	

MODULE	INDUSTRIAL PROCESSES			
SUBMODULE	PRODUCTION OF OTHER CHEMICALS			
WORKSHEET	2 - 10			
SHEET	5 OF 5 SO2 EMISSIONS			
	STEP 2			
Chemical	A Amount of Chemical Produced (t)	B Emission Factor (kg SO2/t chemical produced)	C SO2 Emitted (kg)	D SO2 Emitted (Gg)
			C = (A x B)	$D = C/10^6$
Carbon black	0	3.1	0	0
Sulpheric Acid	135000	17.5	2362500	2.3625
			Total (Gg) :	2.3625

MODULE	INDUSTRIAL PROCESSES		
SUBMODULE	METAL PRODUCTION		
WORKSHEET	2- 11		
SHEET	2 OF 11 IRON & STEEL - TIER 1b - CO_2 EMISSIONS		
	STEP 2		
A Amount of Iron or Steel Produced (t)	B Emission Factor (t CO_2/t of iron or steel produced)	C CO_2 Emitted (t)	D CO_2 Emitted (Gg)
		C = (A x B)	D = C/10^3
278074.5	1.6	444919.2	444.9192

MODULE	INDUSTRIAL PROCESSES		
SUBMODULE	METAL PRODUCTION		
WORKSHEET	2- 11		
SHEET	3 OF 11 IRON & STEEL - Nox, NMVOC, CO, SO2 EMISSIONS		
	STEP 3		
A Amount of Iron or Steel Produced (t)	B Emission Factor (g gas/t of iron or steel produced)	C Gas Emitted (g)	D Gas Emitted (Gg)
		C = (A x B)	D = C/10^9
278074.5	Nox 40	11122980	Nox 0.01112
278074.5	NMVOC 100	27807450	NMVOC 0.0278
278074.5	CO 1300	361496850	CO 0.3615
278074.5	SO_2 1000	278074500	SO_2 0.2781

MODULE	INDUSTRIAL PROCESSES		
SUBMODULE	METAL PRODUCTION		
WORKSHEET	2- 11		
SHEET	5 OF 11 ALUMINUM - TIER 1b - CO2 EMISSIONS		
	STEP 5		
A Amount of Aluminum Produced (t)	B Emission Factor (t CO2/t aluminum produced)	C CO2 Emitted (t)	D CO2 Emitted (Gg)
		C = (A x B)	D = C/10E3
0	1.8	0	0

MODULE	INDUSTRIAL PROCESSES		
SUBMODULE	METAL PRODUCTION		
WORKSHEET	2- 11		
SHEET	8 OF 11 ALUMINUM - TIER 1C - CF4 EMISSIONS		
	STEP 8		
A Amount of Aluminum Produced (t)	B Emission Factor (kg CF4/t aluminum produced)	C CF4 Emitted (kg)	D CF4 Emitted (Gg)
		C = (A x B)	D = C/10E6
0	1.75	0	0

MODULE	INDUSTRIAL PROCESSES	
SUBMODULE	METAL PRODUCTION	
WORKSHEET	2- 11	
SHEET	9 OF 11 ALUMINUM-TIER 1C -CF4 EMISSIONS	
	STEP 8	
A Total of CF4 Emisions (Gg)	B Emission Factor (kg CF4/t aluminum produced)	C CF4 Emitted (Gg)
		C = (A x B)
0	0.1	0

MODULE	INDUSTRIAL PROCESSES		
SUBMODULE	METAL PRODUCTION		
WORKSHEET	2- 11		
SHEET	10 OF 11 ALUMINUM - Nox, CO, SO2 EMISSIONS		
	STEP 3		
A Amount of Aluminum Produced (t)	B Emission Factor (kg gas/t aluminum produced)	C Gas Emitted (kg)	D Gas Emitted (Gg)
		C = (A x B)	D = C/10E6
0	Nox 2.15	0	Nox 0
0	CO 400	0	CO 0
0	SO2 0.9	0	SO2 0

MODULE	INDUSTRIAL PROCESSES	
SUBMODULE	METAL PRODUCTION	
WORKSHEET	2- 11	
SHEET	11 OF 11 ALUMINUM-TIER 1C -CF4 EMISSIONS	
	STEP 8	
A Consumption of SF6 (t)	B Emitted SF6 (t)	C CF4 Emitted (Gg)
	B = A	C = B/1000
0	0	0

MODULE	INDUSTRIAL PROCESSES
SUBMODULE	PULP AND PAPER INDUSTRIES
WORKSHEET	2 - 12
SHEET	1 OF 2 Nox, NMVOC, CO EMISSIONS

STEP 1

Pulp Process Type	A Quantity of Air Dried Pulp Produced (t)	B Emission Factor (kg gas/t air dried pulp produced)	C Gas Emitted (kg)	D Gas Emitted (Gg)
			C = (A x B)	D = C/10^6
Kraft	0	Nox 1.5	0	Nox 0
Kraft	0	NMVOC 3.7	0	NMVOC 0
Kraft	0	CO 5.6	0	CO 0

MODULE	INDUSTRIAL PROCESSES
SUBMODULE	PULP AND PAPER INDUSTRIES
WORKSHEET	2 - 12
SHEET	2 OF 2 SO_2 EMISSIONS

STEP 2

Pulp Process Type	A Quantity of Air Dried Pulp Produced (t)	B Emission Factor (kg SO_2/t air dried pulp produced)	C SO_2 Emitted (kg)	D SO_2 Emitted (Gg)
			C = (A x B)	D = C/10^6
Kraft	0	7	0	0
Acid Sulphite	0	30	0	0
			Total (Gg) :	0

MODULE	INDUSTRIAL PROCESSES
SUBMODULE	FOOD & DRINK
WORKSHEET	2-13
SHEET	1 OF 2 ALCHOHOLIC BEVERAGE PRODUCTION - NMVOC EMISSIONS

STEP 1

Alchoholic Beverage Type	A Quantity of Alchholic Beverage Produced (hl)	B Emission Factor (kg NMVOC/hl bevearge produced)	C NMVOC Emitted (kg)	D NMVOC Emitted (Gg)
			C = (A x B)	D = C/10^6
Wine	20417.7	0.08	1633.416	0.001633416
Red wine	0	0.08	0	0
White wine	0	0.035	0	0
Beer	8612	0.035	301.42	0.00030142
Spirits	0	15	0	0
Malt whiskey	0	15	0	0
Grain whiskey	0	7.5	0	0
Brandy	0	3.5	0	0
			Total (Gg) :	0.001934836

MODULE	INDUSTRIAL PROCESSES
SUBMODULE	FOOD & DRINK
WORKSHEET	2-13
SHEET	2 OF 2 BREAD AND OTHER FOOD PRODUCTION - NMVOC EMISSIONS

STEP 2

Food Production Type	A Quantity of food Produced (t)	B Emission Factor (kg NMVOC/t food processed	C NMVOC Emitted (kg)	D MVOC Emitted (Gg)
			C = (A x B)	D = C/10^6
Meat,fish & Poultry	80,000	0.3	24000	0.024
Sugar	12,800	10	128000	0.128
Margarine	21,590	10	215900	0.2159
Biscuites-Cakes	122,700	1	122700	0.1227
Bread	368,100	8	2944800	2.9448
Animal Feed	0	1	0	0
Coffee Roasting	10,000	0.55	5500	0.0055
			Total (Gg) :	3.4409

MODULE	INDUSTRIAL PROCESSES
SUBMODULE	CONSUMPTION OF HALOCARBONS AND SULPHER HEXAFLOURIDE
WORKSHEET	2-15
SHEET	1 OF 13 - TIER 1A & 1B - BULK HALOCARBONS EMISSIONS
HALOCARBON NAME	HFC134-a

STEP 1

A Quantity of HALOCARBON Produced (t)	B Quantity of HALOCARBON Imported in Bulk (t)	C Quantity of HALOCARBON Exported in Bulk (t)	D Quantity of HALOCARBON Destroyed (t)	E Potential Bulk halocarbon Emission (t)
				E = A + B - C - D
0	2	0	0	2

MODULE	INDUSTRIAL PROCESSES
SUBMODULE	CONSUMPTION OF HALOCARBONS AND SULPHER HEXAFLOURIDE
WORKSHEET	2-15
SHEET	2 OF 13 - TIER 1B - PRODUCT CONTAINING HALOCARBONS
HALOCARBON NAME	

STEP 1

Type of Product Produced	F Number of Units Imported (+) or Exported (-)	G Quantity of Material per Unit (kg)	H Fraction of HALOCARBON in Material (%100)	I Potential Product halocarbon Emission (t)
				$I = F \times G \times H/10^3$
Refrgirators	0	0.5		0
AC units	0	2		0
Central A/C	0	3		0
Cold Stores	0	300-9000		0
Transport Refrig.	0	8		0
Car & Trucks A/C	0	1.5		0
Retail Food Refrig.	0	100		0
Fire Extiguishers				
Solvents				
Foam Products				
Aerosol Cans				
			Total (Gg).	0

2

MODULE	INDUSTRIAL PROCESSES
SUBMODULE	CONSUMPTION OF HALOCARBONS AND HEXAFLOURIDE TIER 1A AND TIER 1B - SUMMARY OF HALOCARBON EMISSIONS
WORKSHEET	2-15
SHEET	3 of 13
HALOCARBON NAME	HFC134-a

STEP 3			
J Potetial Bulk Halocarbon Emissions (t)	K Potetial Product Halocarbon Emissions (t)	L Total Potential Halocarbon Emissions (t)	M Total Potential Halocarbon Emissions (Gg)
J = E from Step I	K = I from step 2	L = J + K	$M = L/10^3$
2	0	2	0.002

APPENDIX 3
NONE

APPENDIX 4
AGRICULTURE IPCC WORKSHEETS

MODULE	AGRICULTURE
SUBMODULE	METHANE AND NITROUS OXIDE EMISSIONS FROM DOMESTIC LIVESTOCK ENTERIC FERMENTATION AND MANURE MANAGEMENT
WORKSHEET	4-1
SHEET	1 OF 2 METHANE EMISSIONS FROM DOMESTIC LIVESTOCK ENTERIC FERMENTATION AND MANURE MANAGEMENT

	STEP 1			STEP 2		STEP 3
Levestock Type	A Number of Animals (1000_s)	B Emissions Factor for Enteric Fermentation (kg/head/yr)	C Emissions from Enteric Fermentation (t/yr) C=(AxB)	D Emissions Factor for Manure Management (kg/head/yr)	E Emissions from Manure Management (t/yr) E=(AxD)	F Total Annual Emissions from Domestic Livestock (Gg) F=(C+E)/1000
Dairy Cattle	46	36	1656	2.00	92.0	1.748
Non- dairy Cattle	30.7	32	982.4	1.00	30.7	1.013
Buffalo	NO	55		5.00		
Sheep	249.3	5	1246.5	0.16	39.9	1.286
Goats	457	5	2285	0.17	77.7	2.363
Camels	1	46	46	1.92	1.92	0.048
Horses	12	18	216	1.64	19.68	0.236
Mules & Asses	31.3	10	313	0.90	28.17	0.341
Swine	41	1.0	41	3.00	123.00	0.164
Poultry	22700	NE		0.018	408.60	0.409
Totals			6785.9		821.67	7.605

MODULE	AGRICULTURE
SUBMODULE	METHAN AND NITROUS OXIDE EMISSIONS FROM DOMESTIC LIVESTOCK ENTERIC FERMENTATION AND MANURE MANAGEMENT
WORKSHEET	4-1(DUPPLEMENTAL)
SPECIFY AWMS	ANAEROBIC LAGOON
SHEET	NITROGEN EXCRETION FOR ANIMAL WASTE MANAGEMENT SYSTEM

Livestock type	A Number of Animals (1000$_s$)	B Nitrogen Excretion Nex (kg/head/(yr)	C Fraction of manure Nitrogen per AWMS (%/100) (fraction)	D Nitrogen excretion per AWMS . Nex (kg N /yr)
				D=(AxBxC)
Non - dairy Cattle	30.7	50	0.0	0.0
Dairy	46	70	0.0	0.0
Poultry	22700	0.6	0.0	0.0
Sheep	249.3	12	0.0	0.0
Swine	41	16	0.0	0.0
Other	501.3	40	0.0	0.0
			Total	0.0

MODULE	AGRICULTURE
SUBMODULE	METHAN AND NITROUS OXIDE EMISSIONS FROM DOMESTIC LIVESTOCK ENTERIC FERMENTATION AND MANURE MANAGEMENT
WORKSHEET	4-1(SUPPLEMENTAL)
SPECIFY AWMS	Liquid System
SHEET	NITROGEN EXCRETION FOR ANIMAL WASTE MANAGEMENT SYSTEM

Livestock type	A Number of Animals (1000_s)	B Nitrogen Excretion Nex (kg/head/(yr)	C Fraction of manure Nitrogen per AWMS (fraction)	D Nitrogen excretion per AWMS . Nex (kg N /yr)
				D=(AxBxC)
Non - dairy Cattle	30.7	50	0.0	0.0
Dairy	46	70	0.0	0.0
Poultry	22700	0.6	0.01	$136.2x10^3$
Sheep	249.3	12	0.0	0.0
Swine	41	16	0.32	$209.9x10^3$
Other	501.3	40	0.0	0.0
			Total	$346.1x10^3$

MODULE	AGRICULTURE
SUBMODULE	METHAN AND NITROUS OXIDE EMISSIONS FROM DOMESTIC LIVESTOCK ENTERIC FERMENTATION AND MANURE MANAGEMENT
WORKSHEET	4-1(SUPPLEMENTAL)
SPECIFY AWMS	**Daily spread**
SHEET	NITROGEN EXCRETION FOR ANIMAL WASTE MANAGEMENT SYSTEM

Livestock type	A Number of Animals (1000$_s$)	B Nitrogen Excretion Nex (kg/head/(yr)	C Fraction of manure Nitrogen per AWMS (fraction)	D Nitrogen excretion per AWMS . Nex (kg N /yr)
				D=(AxBxC)
Non - dairy Cattle	30.7	50	0.02	30.7×10^3
Dairy	46	70	0.03	96.6×10^3
Poultry	22700	0.6	0.0	0.0
Sheep	249.3	12	0.0	0.0
Swine	41	16	0.0	0.0
Other	501.3	40	0.0	0.0
			Total	127.3×10^3

MODULE	AGRICULTURE
SUBMODULE	METHAN AND NITROUS OXIDE EMISSIONS FROM DOMESTIC LIVESTOCK ENTERIC FERMENTATION AND MANURE MANAGEMENT
WORKSHEET	4-1(SUPPLEMENTAL)
SPECIFY AWMS	Solid Storage and drylot
SHEET	NITROGEN EXCRETION FOR ANIMAL WASTE MANAGEMENT SYSTEM

Livestock type	A Number of Animals (1000_s)	B Nitrogen Excretion Nex (kg/head/(yr)	C Fraction of manure Nitrogen per AWMS (fraction)	D Nitrogen excretion per AWMS . Nex (kg N /yr)
				D=(AxBxC)
Non - dairy Cattle	30.7	50	0.46	$706.1x10^3$
Dairy	46	70	0.48	$1545.6x10^3$
Poultry	22700	0.6	0.71	$9670.2x10^3$
Sheep	249.3	12	0.00	0.0
Swine	41	16	0.68	$446.1x10^3$
Other	501.3	40	0.00	0.0
			Total	$12368.0x10^3$

MODULE	AGRICULTURE
SUBMODULE	METHAN AND NITROUS OXIDE EMISSIONS FROM DOMESTIC LIVESTOCK ENTERIC FERMENTATION AND MANURE MANAGEMENT
WORKSHEET	4-1 (SUPPLEMENTAL)
SPECIFY AWMS	**Pasture Range and Paddock**
SHEET	NITROGEN EXCRETION FOR ANIMAL WASTE MANAGEMENT SYSTEM

Livestock type	A Number of Animals (1000_s)	B Nitrogen Excretion Nex (kg/head/(yr)	C Fraction of manure Nitrogen per AWMS (fraction)	D Nitrogen excretion per AWMS . Nex (kg N /yr)
				D=(AxBxC)
Non - dairy Cattle	30.7	50	0.5	767.5×10^3
Dairy	46	70	0.5	1610.0×10^3
Poultry	22700	0.6	0.0	0.0
Sheep	24..3	12	1.0	2991.6×10^3
Swine	41	16	0.0	0.0
Other	501.3	40	1.0	20052.0×10^3
			Total	25421.1×10^3

MODULE	AGRICULTURE
SUBMODULE	METHAN AND NITROUS OXIDE EMISSIONS FROM DOMESTIC LIVESTOCK ENTERIC FERMENTATION AND MANURE MANAGEMENT
WORKSHEET	4-1 (SUPPLEMENTAL)
SPECIFY AWMS	**Used Fuel**
SHEET	NITROGEN EXCRETION FOR ANIMAL WASTE MANAGEMENT SYSTEM

Livestock type	A Number of Animals (1000_s)	B Nitrogen Excretion Nex (kg/head/(yr)	C Fraction of manure Nitrogen per AWMS (fraction)	D Nitrogen excretion per AWMS . Nex (kg N /yr)
Non - dairy Cattle	30.7	50	0.0	0.0
Dairy	46	70	0.0	0.0
Poultry	22700	0.6	0.0	0.0
Sheep	249.3	12	0.0	0.0
Swine	41	16	0.0	0.0
Other	501.3	40	0.0	0.0
			Total	0.0

MODULE	AGRICULTURE
SUBMODULE	METHAN AND NITROUS OXIDE EMISSIONS FROM DOMESTIC LIVESTOCK ENTERIC FERMENTATION AND MANURE MANAGEMENT
WORKSHEET	4-1(SUPPLEMENTAL)
SPECIFY AWMS	Other system
SHEET	NITROGEN EXCRETION FOR ANIMAL WASTE MANAGEMENT SYSTEM

Livestock type	A Number of Animals (1000_s)	B Nitrogen Excretion nex (kg/head/(yr)	C Fraction of manure Nitrogen per AWMS (100%) (fraction)	D Nitrogen excretion per AWMS . Nex (kg N /yr)
				D=(AxBxC)
Non - dairy Cattle	30.7	50	0.02	30.7×10^3
Dairy	46	70	0.0	0.0
Poultry	22700	0.6	0.28	3813.6×10^3
Sheep	249.3	12	0.0	0.0
Swine	41	16	0.0	0.0
Other	501.3	40	0.0	0.0
			Total	3844.3×10^3

MODULE	AGRCULTURE
SUBMODULE	METHANE AND NITOUS OXIDE EMISSIONS FROM DOMESTIC LIVESTOCK ENTRIC FERMENTATION AND MANURE MANAGEMENT
WORKSHEET	4-1
SHEET	2 OF 2 NITROUS OXID EMISSION FROM ANIMAL PRODUCTION EMISSIONS FROM ANIMAL WASTE MANAGEMENT SYSTEMS(AWMS)

STEP 4

Animal Waste Management System (AWMS)	A Nitrogen Excretion $Nex_{(AWMS)}$ (kg N/yr)	B Emission Factor for AWMS EF_3 (kg N_2O-N/kgN)	C Total Annual Emissions of N_2O (Gg)
			$C=(AxB)(44/28)x10^{-6}$
Anaerobic lagoons	0.0	0.001	0.0
Liquid Systems	$346.1x10^{3}$	0.001	$0.544x10^{-3}$
Daily spread	$127.3x10^{3}$		
Solid storage & drylot	$12367.9x10^{3}$	0.020	$388.705x10^{-3}$
Pasture range and paddock	$25421.1x10^{3}$		
Other	$3844.3x10^{3}$	0.005	$30.205x10^{-3}$
Totals	$42106.7x10^{3}$		$419.454x10^{-3}$

MODULE	AGRICULTURE
SUBMODULE	FIELD BURRNING OF AGRICULTURAL RESIDOUES
WORKSHEET	4-4
SHEET	1OF 3

	STEP1		STEP2		STEP3			
Crops (specify locally important crops)	A Annual Production (Gg crop)	B Residue to crop Ratio	C Quantity of Residue (Gg Biomass)	D Dry Matter Fraction	E Quantity of Dry rsidue (Gg dm)	F Fraction Burned in Fields	G fraction Oxidised	H total Biomas Burnec (Gg dn
			C=(AxB)		E=(CxD)			H=(ExFx
Wheat	50.333	1.3	65.433	0.78	51.037	0.01	0.9	0.459
Barlay	21.000	1.2	25.2	0.78	19.656	0.01	0.9	0.177
Oats	1.000	1.3	1.3	0.78	1.014	0.01	0.9	0.009
Total:								0.645

MODULE	AGRICULTURE
SUBMODULE	FIELD BURNING OF AGRICULTURAL RESIDUES
WORKSHEET	4-4
SHEET	2 OF 3

	STEP4		STEP5	
	I Carbon Fraction of Residue	J Total Carbon Released (Gg C)	K Nitrogen- Carbon Ratio	L Total Nitrogen Relased (Gg N)
		J=(HxI)		L=(JxK)
	0.4853	0.2227	0.012	0.00267
	0.4567	0.0808	0.012	0.00097
	0.4567	0.0041	0.012	0.00005
Total :		0.3076		0.0370

MODULE	AGRICULTURE
SUBMODULE	FIELD BURNINC OF AGRICULURAL RESIDUES
WORKSHEET	4-4
SHEET	3 OF 3

	STEEP6			
	M Emission Ratio	N Emission (GgCor Gg N)	O Conversion Ratio	P Emission from Field Burning of Agricultural Residues (Gg)
		N=(JxM)		P=(NxO)
CH_4	0.005	0.001538	16/12	0.00205
CO	0.06	0.018456	28/12	0.04306
		N=(LxM)		P=(NxO)
N_2O	0.007	0.000026	44/28	0.00004
NO_x	0.0121	0.000447	46/14	0.00146

MODULE	AGRICULTURE
SUBMODULE	AGRICULTURAL SOILS
WORKSHEET	4-5
SHEET	1OF 5 DIRECT NITROUS OXIDE EMISSIONS FROM AGRICUTURAL FIELDS, EXCLUDING CULTIVATION OF HISTOSOLS

	STEP 1	STEP 2	
Type of N input to soil	A Amount of N Input (kg N/yr)	B emission Factor for Direct Emissions EF_1 (kg N_2O -N/kg N)	C Direct soil Emissions (Gg N_2O -N /yr) $C=(A \times B) \times 10^{-6}$
Synthetic fertiliser (F_{SN})	13380×10^3	0.125	0.6725
Animal waste (F_{AW})	$7347.\times 10^3$	0.125	0.9184
N-fixing crops (F_{BN})	3870×10^3	0.125	0.4837
Crop residue (F_{CR})	24746×10^3	0.125	0.0932
		Total	0.1679

MODULE	AGRCULTURE
SUBMODULE	AGRICULTURAL SOILS
WORKSHEET	4-5 A (SUPPLEMENTAL)
SHEET	1 OF 1 MANURE NITROGEN USED

A Total Nitrogen Excretion (kg N/yr)	B Fraction of Nitrogen Burned for Fuel (fraction)	C Fraction of Nitrogen Excreted During Grazing (fraction)	D Fraction of nitrogen Excreted Emitted as NO_x and NH_3 (fraction)	E Sum (fraction)	F Manure Nitrogen (Corrected for NO_x and NH_3 emission) kg N/yr
				F= 1-(B+C+D)	F= ExA
$42106,7x10^3$	0.0	0.6	0.2	0.2	$8421.34x10^3$

MODULE	AGRCULTURE
SUBMODULE	AGRICULTURAL SOILS
WORKSHEET	4-5 B (SUPPLEMENTAL)
SHEET	1 OF 1 NITROGE N INPUT FROM CROP RESIDUES

A Production of non-N- Fixing Crops (kg dry biomass/yr)	B Fraction of Nitogen of non-N- Fixing Crops (kg N/kg dry biomass)	C Production of Pulses and Soybeans (kg dry biomass/yr)	D Fraction of Nitrogen in N - Fixing Crops (kg N/kg dry biomass)	E One minus the Fraction of Crop Residue Removed From Feld (fraction)	F One minus the Fraction of Crop Residue Burned (fraction)	G Nitrogen Inpué from Crop Residues (kg N/yr)
$1370.8x10^6$	0.015	$64.5x10^6$	0.03	(1-0.45)	(1-0.0)	$24.747x10^6$

MODULE	AGRCULTURE
SUBMODULE	AGRICULTURAL SOILS
WORKSHEET	4-5
SHEET	2 OF 5 DIRECT NITROUS OXIDE EMISSIONS FROM CULTIVATION OF HISTOSOLS

	STEP 3			STEP 4
	D Area of Cultivated Organic Soils F_{os} (ha)	E Emission Facteur for Direct Soil Emission EF_2 (kg N_2O -N/ha/yr)	F Direct Emission from Histosols (Gg N_2O-N / yr)	G Total Direct Emission of N_2O (Gg)
			$F=(DxE)x10^{-6}$	$G=(C+F)(44/28)$
Subtotal	0.0	5	0.0	0.96924

MODULE	AGRCULTURE
SUBMODULE	AGRICULTURAL SOILS
WORKSHEET	4-5
SHEET	3 OF 5 NITROUS OXIDE SOIL EMISSIONS FROM GRAZING ANIMALS PASTUR RANGE AND PADDOCK

STEP 5			
Animal Waste Management System (AWMS)	A Nitrogen Excretion N_{EX} ($_{AWMS}$) (kg N/yr)	B Emission Factor for AWMS EF_3 (kg N_2O-N/kgN)	C Emission of N_2O from Grazing Animals (Gg)
			$C=(AxB)(44/28)x10^{-6}$
Pasture range & paddock	$25421.1x10^3$	0.02	0.79895

MODULE	AGRICULTURE							
SUBMODULE	AGRICULTURAL SOILS							
WORKSHEET	4-5							
SHEET	4 OF 5 INDIRECT NITROUS OXIDE EMSSIONS FROM ATMOSPHERIC DEPOSITION OF $NH_{3\ AND}\ NO_x$							
	STEP 6							
Type of Deposition	A Synthetic Fertiliser N Applied to soil , N_{FERT} (kg N/yr)	B fraction of synthetic Fertiliser N Applied that Volatilizes Frac $_{GASFS}$ (kg N/kg N)	C Amount of Synthetic N Applied to Soil that Volitilizes (kg N/kg N)	D Total N Excretion by Livestock N_{EX} (kg N/yr)	E Fraction of Total Manure N Excreted that volatilizes Frac $_{GASM}$ (kg N/kgN)	F Total N Excretion by Livestock that Volatilizes (kgN/kgN)	G Emission Factor EF_4 (kg N_2 O-N/Kg N)	H Nitrous Oxide Emissions (gg N_2 O -N/yr)
			C=(AxB)			F=(Dx E)		H=(C+F) x Gx 10^{-6}
Total	$14866.6x10^3$	0.1	$1486.66x10^3$	$42106.7x10^3$	0.2	$8421.34x10^3$	0.01	0.09908

WORKSHEET	4-5							
SHEET	5 OF 5 INDIRECT NITROUS OXIDE EMSSIONS FROM LEACHING							
	STEP 7						STEEP8	STEEP9
	I Synthetic Fertiliser Use N_{FERT} (kg N/yr)	J Livestock N Excretion N_{EX} (kg N/yr)	K Fraction of N that Leaches $Frac_{LEACH}$ (kg N/kg N)	L Emission Factor EF_5	M Nitrous Oxide Emissions From Leaching (Gg N_2 O-N/yr)		N Total Indirect Nitrous Oxide Emissions (Gg N_2 O-N/yr)	O Total Nitous Oxide Emissions (Gg)
	$14866.6x10^3$	$42106.7x10^3$	0.3	0.025	$M=(I+J)xKxLx10^{-6}$) 0.42729		N=(H+M) (44/28) 0.8275	O=(G+C+N) (G from worksheet 4 -5 , sheet 2,step 4;C from worksheet 4-5 , sheet 3,step5;N from worksheet 4-5 sheet 5, step 8)
Total								2.59534

APPENDIX 5
LAND USE CHANGE AND FORESTRY IPCC WORKSHEETS

APPENDIX 6
WASTE IPCC WORKSHEETS

	MODULE	WASTE	
	SUBMODULE	METHANE CORRECTION FACTOR	
	WORKSHEET	6-1C (SUPPLEMENTAL)	
	SHEET	1 OF 1	
	W	X	Y
Type of Site	Proportion of Waste (by weight) for Each Type of SWDSs	Methane Correction Factor (MCF)	Weighed Average MCF for Each Type of SWDS
			Y= W x X
Managed		1.0	
Unmanaged – deep (> 5m waste)	1	0.8	0.8
Unmanaged – shallow (< 5m waste)		0.4	
Total	1	0.6	0.8

MODULE	**WASTE**
SUBMODULE	**METHANE EMISSIONS FROM SOLID WASTE DISPOSAL SITES**
WORKSHEET	**6-1**
SHEET	**1 OF 1**

STEP 1	STEP 2	STEP 3						STEP 4				
A Total Annual MSW Disposed to SWDs (Gg MSW)	B Methane Correction Factor (MCF)	C Fraction of DOC in MSW	D Fraction of DOC Which Actually Degrades	E Fraction of Carbon Released as Methane	F Conversion Ratio	G Potential Methane Generation Rate per Unit of Waste (Gg CH_4/Gg MSW)	H Realised (Country-Specific) Methane Generation Rate per Unit of Waste (Gg CH_4/ Gg MSW)	J Gross Annual Methane Generation (Gg CH_4)	K Recovered Methane Per Year (Gg CH_4)	L Net Annual Methane Generation (Gg CH_4)	M One Minus Methane Oxidation Correction Factor	N Net Annual Methane Emissions (Gg CH_4)
						G= (C x D x E x F)	H= (B x C)	J= (H x A)		L = (J - K)		N= (L x M)
0.615	0.8	0.17	0.77	0.5	16/12	0.087	0.136	0.0837	0	0.0837	1	0.0837