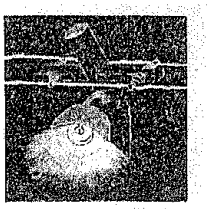


APPENDIX 1B

OTHER ENERGY ACTIVITY DATA (1994)

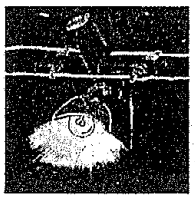
Biomass Fuel Consumption (KTOE)	
Industry	
Wood/Wood Waste	134.92
Charcoal	
Bagasse	1,495.00
Agriwaste	4,284.63
Other Solid Biomass	
Residential	
Wood/Wood Waste	4,228.99
Charcoal	962.68
Crop Residues (Agriwaste)	898.21

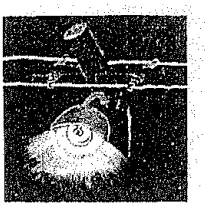
Ozone Precursors and SO_2 from Oil Refining	
Crude Oil Throughput (kt)	9,004.00

Ozone Precursors and SO_2 from Catalytic Cracking	
Crude Oil Throughput (kt)	376.00

CH_4 Emissions from Coal Mining and Handling		
Type of Mine	**Mining Activity**	**Amt. of Coal Produced (million t)**
Underground Mines	Mining	0.73
	Post-Mining	0.73
Surface Mines	Mining	0.72
	Post-Mining	0.72

CH_4 Emissions from Oil and Gas Activities	
Category	**Activity**
Oil	
Production	oil produced (PJ)
	10.69
Transport	oil loaded in tankers (PJ)
	506.11
Refining	oil refined (PJ)
	497.75
Storage	oil refined (PJ)
	497.75





APPENDIX 1C

CONVERSION FACTORS

Barrels (bbl) to ktoe conversion factors for liquid fuels

Liquid Fuel Types	Conversion Factors (ktoe/bbl)
Crude Oil	0.000134
Gasoline	
Premium	0.000125
Regular	0.000122
Unleaded	0.000125
Kerosene	0.000127
Diesel	0.000135
Fuel Oil	0.000144
LPG	0.000092
Avturbo	0.000127
Naptha	0.000124
Asphalt	0.000152
Avgas	0.000122
Lube/Grease	0.000146

Source: Department of Energy

MMBFOE to ktoe conversion factors for solid fuels

Solid Fuel Types	Conversion Factors (ktoe / MMBFOE)
Coal	162.38
Solid Biomass	144.4

Mass

1 ton = 1000 kg

1 Gigagram (Gg) = 10^6 kg

Volume

1 barrel (bbl) = 158.99 liters

1 gallon = 3.788 liters

Area

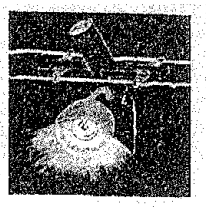
1 square meter = 10.7639 square feet

1 square kilometer = 100 hectares

1 hectare = 10,000 square meters

Scientific Notation

1 000 000 000 = 10^{12}	Tera
1 000 000 000 = 10^9	Giga
1 000 000 = 10^6	Mega
1 000 = 10^3	Kilo



ENERGY SECTOR

Workbook

1.1 INTRODUCTION

Greenhouse gas (GHG) emissions from the Energy sector come from the combustion of fuels and other activities related to the production of energy, such as coal mining, oil and gas explorations, production, and processing. Activity data for 1994 can be found in Appendix 1A (OEB sheet) and Appendix 1B of the Reference Manual.

The following table outlines the five main sections of this workbook and their corresponding worksheets:

Worksheet 1-1A	CO_2 from Fuel Combustion: Top-Down Approach
Worksheet 1-1B	CO_2 from Fuel Combustion: Bottom-Up Approach
Worksheet 1-2	Non-CO_2 Gases from Fuel Combustion (CH_4, N_2O, CO, NO_x, NMVOC)
Worksheet 1-3A	CH_4 Emissions from Coal Mining and Handling
Worksheet 1-3B	CH_4 Emissions from Oil/Gas Activities
Worksheet 1-3C	GHG Precursors and SO_2 from Oil Refining/Catalytic Cracking
Worksheet 1-4	SO_2 Emissions from Fuel Combustion
Worksheet 1-5A	CO_2 from Combustion of Biomass Fuels
Worksheet 1-5B	Emissions from International Bunkers
Worksheet 1-SA	CO_2 from Fuel Combustion Bottom- Up Approach: An Overview
Worksheet 1-SB	National Greenhouse Gas Inventory from the Energy Sector

For each section, an overview is first presented which includes the data requirements for each calculation and the possible sources of these data. Following this, the specific steps for completing the worksheets are then described.

1.2 CO_2 Emissions from Fuel Combustion

The two methods for calculating CO_2 emissions from the combustion of fossil fuels are the top-down and the bottom-up approach. See Sections 1.2.1 and 1.2.2 of the Reference Manual for a detailed discussion of these methods.

The basic formula for computing carbon emissions is given by the Revised 1996 IPCC Guidelines as:

$$Carbon\ Emissions = \sum (A_{ij} \times EF - C) \times B$$

where A is the fuel consumption in energy units (TJ), EF is the emission factor (t C/TJ), B is fraction of carbon oxidized, and C is carbon stored (TJ) or carbon that is not used in energy activities. The summation is carried over all energy subsectors and fuel types.

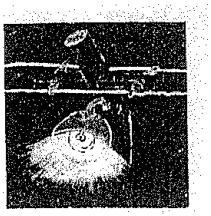
1.2.1 Top-Down or Reference Approach

The amount of CO_2 emitted in the top-down approach is calculated based on the overall national fuel inventory. This requires information on the different fuel types involved in the following activities:

- production
- importation
- exportation
- transport through international bunkers
- stock change

Data may be obtained from the Overall Energy Balance (OEB) sheet published by the Department of Energy (DOE). The 1994 OEB Sheet is reproduced in Appendix 1 of the Reference Manual.

The 1994 local fuel classification table is listed in Table 1-1 of the Reference Manual. Use **Worksheets 1-1A** for the step-by-step computations.



Step 1 Computing for the Apparent CO_2 Consumption
Worksheet 1-1A, Sheet 1 of 3

1 For each fuel type, enter the data (in ktoe) on fuel production, import, export, transport through international bunkers, and stock change into Columns A, B, C, D, and E, respectively.

2 Column F, gives the apparent consumption by using the formula:

$$F = A + B - C - D - E$$

Refer to Equation 1-2 of Section 1.2.1 of the Reference Manual for a clear definition of this equation.

Step 2 Expressing the Apparent CO_2 Consumption in TJ
Worksheet 1-1A, Sheet 2 of 3

3 Enter the conversion factor, 41.87 TJ/ktoe, in Column G.

4 In Column H compute the apparent consumption (in TJ), by multiplying Column G with Column F.

Step 3 Estimating Fuel Carbon Content

5 Input the carbon emission factors (in t C/TJ) for each fuel type in Column I. Refer to Table 1-2 of the Reference Manual for the default emission factors.

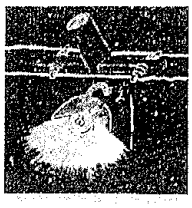
6 In Column J, get the carbon content (in t C) by multiplying Columns H and I.

7 In Column K, convert the results to units of Gg C by multiplying the values in Column J by 10^{-3}.

Step 4 Estimating Net Carbon Emissions
Worksheet 1-1A, Sheet 3 of 3

8 Input the amount of carbon stored for each fuel type in Column L. Refer to Section 1.2 of the Reference Manual for a discussion on stored carbon.

9 In Column M, subtract Column L from Column K to get the net carbon emissions.



Step 5 Estimating Actual Carbon Emissions

10 Set the fraction of carbon oxidized in Column N. Refer to the IPCC default values in Table 1-3 of the Reference Manual.

11 Multiply Columns M and N to get the actual carbon emissions in Gg of C in Column O.

Step 6 Estimating Actual CO_2 Emissions

12 Finally, in Column P, compute the actual CO_2 emissions (in Gg) by multiplying Column O by 44/12, which is the molecular weight ratio of CO_2 to C, converting carbon to CO_2 emissions.

1.2.2 Bottom-Up or Sectoral Approach

The preceding section calculates CO_2 emissions by considering the overall national inventory of fuel supply. Another approach is to look at the actual consumption of the specific subsectors. The subsectors are identified as the following: energy (or power generation) industries, transportation, manufacturing, residential, commercial, and agriculture. Fuel consumption data are contained in the OEB sheet.

The methodology is basically the same as in the reference approach but is more detailed in the sense that it is applied for each specified end user. Use **Worksheet 1-1B** for the step-by-step computations.

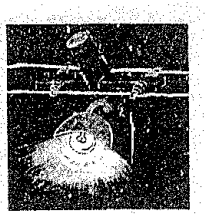
Step 1 Fuel Consumption in ktoe Units

1 For each subsector, enter the fuel consumption in ktoe for each type of fuel in the first column (Column A).

Step 2 Calculating for the Apparent Fuel Consumption (in TJ) for Each Fuel Type

2 In Column B, enter the appropriate conversion factor (41.87 TJ/ktoe) to convert into energy units (TJ).

3 Compute the apparent consumption (in TJ) in Column C by multiplying Column A with Column B.



Step 3 Estimating the Carbon Content for Each Fuel Type

4 Input the carbon emission factors (in t C/TJ) listed in Table 1-2 of the Reference Manual for each fuel type in Column D.

5 In Column E, get the carbon content (in t C) by multiplying Columns C and D.

6 Convert to units of Gg C by multiplying the values in Column E by 10^{-3}.

Step 4 Estimating Net Carbon Emissions

7 Input the fraction of carbon stored for each fuel type in Column G. Refer to Section 1.2 of the Reference Manual for a discussion on stored carbon.

8 Compute the amount of carbon stored (in Gg of C) in Column H by multiplying Columns F and G.

9 In Column I, subtract Column H from Column F to get the net carbon emissions.

Step 5 Estimating Actual Carbon Emissions

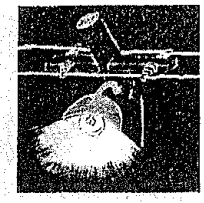
10 Enter the fraction of carbon oxidized in Column J. Refer to Table 1-3 of the Reference Manual for the default values.

11 Multiply Columns I and J in Column K to get the actual carbon emissions (in Gg of C).

Step 6 Estimating Actual CO_2 Emissions

12 Finally, in Column L, compute the actual CO_2 emissions (in Gg) by multiplying Column K by 44/12.

These steps (Steps 1 to 6) are followed for all the energy subsectors specified above.



1.3 Non-CO_2 from Fuel Combustion by Subsector

Greenhouse gases other then CO_2 are also emitted during fuel combustion. When coal, gasoline, diesel, wood/woodwaste, charcoal, and other biomass fuels are burned, the following non-CO_2 gases are emitted: methane (CH_4), nitrous oxide (N_2O), nitrogen oxides (NO_x), carbon monoxide (CO), and non-methane volatile organic compounds (NMVOCs). The complete list of biomass fuel categories can be found in Table 1-1 of the Reference Manual.

Coal, oil, and biomass fuel consumption are the basic data requirements and these can be found in the OEB sheet. Interpolation is done if data on years other than the inventory year are available. (Please refer to Section 1.3.1 of the Reference Manual for details regarding the interpolation process). In 1994, no data was available on residential biomass consumption. However, the UNDP-ESMAP study on household energy consumption contains data for 1989 and projected values for 1995 and 2000.

The worksheets for this section (**Worksheets 1-2**) provide the steps for computing non-CO_2 emissions from fuel combustion in each source category. The gases involved are CH_4, N_2O, NO_x, CO, and NMVOCs.

Supplementary Step: Converting from kton to TJ

This is an optional step, to be considered only if the raw data are in units of kton (kt)

Supplementary Worksheet 1-2: Converting from kton to TJ

1 In Column A, enter the biomass consumption data on wood/woodwaste, charcoal, and crop residue in kilotons (kt).

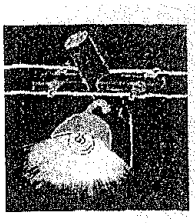
2 The conversion factors in ktoe/kt are already in Column B. In Column C, convert consumption units to ktoe by multiplying Columns A and B.

3 In Column D multiply Column C by 41.868 to convert to units of TJ.

Step 1 Estimating Fuel Consumption per Fuel Type

Worksheet 1-2, Sheet 1 of 3

4 For each subsector, enter the fuel consumption (in TJ) for each fuel type; coal in Column A1, oil in A2, wood/waste in A3, charcoal in A4, and other biomass/waste in A5.



Step 2 Emission Factors
Worksheet 1-2, Sheet 2 of 3

5 Input the emission factors (in kg/TJ) for each fuel type in the B Columns, i.e. B1 for coal, B2 for oil, and so on. Refer to Tables 1-6 to 1-10 of the Reference Manual for the different emission factors of the five non-CO_2 trace gases.

Step 3 Estimating Actual Emissions
Worksheet 1-2, Sheet 3 of 3

6 In the C Columns (C1, C2, C3, etc.), compute the emissions per fuel type by multiplying corresponding Columns of A and B, i.e. C1 = A1 x B1, C2 = A2 x B2, and so on.

7 Finally, in Column D, sum Columns C1 to C6 and multiply by 10^6 to get the net non-CO_2 trace gas emissions (in kg) for each energy subsector.

These steps are followed for all non-CO_2 gases. The only parameter that is varied is the emission factor which is dependent on the type of trace gas.

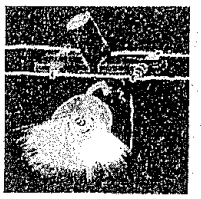
1.4 Fugitive Emissions

The processes of fuel extraction, transport, storage, and refining also lead to the release of GHGs, CH_4 in particular, and other non-CO_2 trace gases into the atmosphere. This section accounts for these fugitive emissions from three activities: coal mining/handling, oil/gas activities, and oil refining.

1.4.1 CH_4 Emissions from Coal Mining and Handling

Coal mining and other post-mining activities release CH_4 into the air. These emissions depend on the type of mining process, which can either be underground or surface mining. Refer to Section 1.4.1 of the Reference Manual for further discussions on CH_4 emissions from coal mining and handling.

The basic data requirements are coal production values for each type of mining process which can be obtained from the Coal and Mining Division of the DOE. Use **Worksheet 1-3A** for the step-by-step calculation.



Worksheet 1-3A, Sheet 1 of 1

1 For each type of mine and for mining activity, enter in Column A the amount of coal produced (in million tons). Note that the same coal production data are used for both mining and post-mining activities since the same amount of coal is involved in these two processes.

2 In Column B, enter the emission factors (in m^3 CH_4/t). Refer to Table 1-11 of the Reference Manual. In the 1994 inventory, the average of the minimum and maxium values listed was utilized.

3 Compute CH_4 emissions (in million m^3 of CH_4) in Column C by getting the product of Columns A and B.

Step 2 Converting CH_4 Emissions to Units of Gg

4 In Column D, input the factor $0.67/10^6 m^3$. (This will convert the units of Column C from million m^3 CH_4 to Gg of CH_4).

5 Get the net CH_4 emissions from coal mining in Gg of CH_4 in Column E by multiplying Columns D and C.

1.4.2 Fugitive Emissions from Oil and Gas Activities

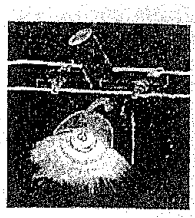
Oil activities (such as production, transport, refinery) and gas activities (such as production, processing, transmission, and distribution) are all potential sources of CH_4 emissions.

The basic data needed are the amount of oil produced, refined and transported and these are available from the Oil and Gas Division of the DOE. Gas exploration in the Philippines commenced only in 1994. Use **Worksheet 1-3B** for the step-by-step computations.

Step 1 Estimating CH_4 Emissions from Oil and Gas Related Activities

Worksheet 1-3B, Sheet 1 of 1

1 In Column A, enter the amount of oil in PJ (1 PJ = 10^{15} J) involved in production, transport, and refining.



2 The emission factors are already entered in Column B for each activity. (These factors are also listed in Table 1-12 of the Reference Manual.) Compute the CH_4 emissions (in kg of CH_4) in Column C by multiplying Columns A and B.

3 Finally, get the net emissions in Gg of CH_4 by dividing Column C by 10^6.

1.4.3 GHG PRECURSORS AND SO_2 FROM OIL REFINING

Converting crude oil into its derivatives (e.g. gasoline, diesel, LPG, kerosene, etc) in oil refineries releases CO, NO_x, NMVOCs, and SO_2 into the atmosphere. Storage and handling of oil products also emit NMVOCs.

To calculate these emissions, data on crude oil throughput and catalytic cracker throughput are needed. These data may be requested from oil refining companies.

Use **Worksheet 1-3C** for computing the emissions of GHG precursors CO, NO_x, NMVOC, and SO_2 from oil refining processes.

Step 1 Estimating Emissions from Oil Activities
Worksheet 1-3C, Sheet 1 of 3: GHG Precursors and SO_2 from Oil Refining

1 Enter the crude oil throughput (in kt) in Column A.

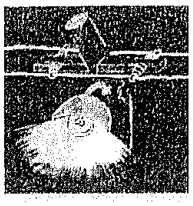
2 The trace gases CO, NO_x, NMVOC, and SO_2, are enumerated in Column B and the corresponding emission factors (in kg/t) are already entered in Column C. (The emission factors are also listed in Table 1-13 of the Reference Manual.) In Column D, compute the emissions (in t) by multiplying Columns A and C.

3 In Column E, get the net emissions (in Gg) by dividing Column D by 1000.

Step 2 Estimating Emissions from Catalytic Cracking
Worksheet 1-3C, Sheet 2 of 3: GHG Precursors and SO_2 from Catalytic Cracking

4 Input the catalytic cracker throughput (in kt) in Column A.

5 The trace gases CO, NO_x, NMVOC, and SO_2, are listed Column B and the corresponding emissions factors (in kg/t) are already set in Column C. (The



emission factors are also listed in Table 1-14 of the Reference Manual.) Compute emissions (in t) by multiplying Columns A and C.

6 In Column E, get the net emissions in Gg by dividing Column D by 1000.

Worksheet 1-3C, Sheet 3 of 3: NMVOC Emissions from Storage and Handling

7 In Column A, enter the crude oil throughput (in kt). The storage types, (secondary seals, primary seals, and fixed roof), are listed in Column B and the corresponding emissions factors (in kg/t) given in Column C. (The emission factors are also listed in Table 1-15 of the Reference Manual.)

8 Compute NMVOC emissions (in t) in Column D by multiplying Columns A and C.

9 Convert the net emissions to Gg by dividing Column D by 1000.

1.5 SO_2 Emissions from Fuel Combustion

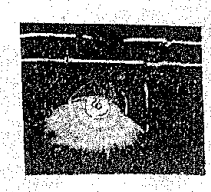
Sulfur dioxide (SO_2) is not a GHG, but it has the potential to modify regional or local climate via the formation of sulfate aerosols. SO_2 emissions from fuel combustion in the different subsectors are computed in this section. (Refer to Section 1.5 of the Reference Manual for a detailed discussion on SO_2 emissions from fuel combustion activities.)

Fuel consumption data for fuel types that contain sulfur are found in the OEB sheet. The DOE has information on the percentage of sulfur content of certain fuel types. Default IPCC values are used for the other fuel types. Listed in Table 1-16 of the Reference Manual are the sulfur containing fuel types and the corresponding sulfur content. Use Worksheet **1-4** for the step-by-step calculations.

Worksheet 1-4, Sheet 1 of 1

1 Enter fuel consumption (in TJ) for each fuel type for each subsector in Column A.

2 In Column B, enter the % sulfur content of the fuel. Refer to Table 1-16 of the Reference Manual for the sulfur content of the different fuel types.



3 The default IPCC values for % sulfur retention in ash are already entered in Column C.

4 If applicable, enter the abatement efficiency (in %) in Column D. (No local information is available for the year 1994, hence, it is assumed that there are no local sulfur abatement activities.)

5 In Column E, enter the net calorific value (in TJ/kt). See Table 1-17 of the Reference Manual for the net calorific values of the different fuel types.

6 In Column F, compute the SO_2 emission factor (in kg/TJ) for each fuel type by using the following formula:

$$SO_2\ Emission\ Factor = 2\times\left(\frac{B}{100}\right)\times\left(\frac{1}{E}\right)\times 10^6\times\left(\frac{100-C}{100}\right)\times\left(\frac{100-D}{100}\right)$$

(Refer to Equation 1-7 of Section 1.5 of the Reference Manual for a detailed discussion of the above formula.)

7 Finally, in Column G compute the SO_2 emissions (in t) by multiplying Columns A and F and dividing the product by 1000.

1.6 Memo Items

CO_2 emissions from biomass fuel combustion and international bunkers are recommended for inclusion as memo items by the IPCC Guidelines. The resulting CO_2 emissions are not included in the overall total of energy-related GHG emissions.

1.6.1 CO_2 from Biomass Fuels

The methodology of Section 1.2.2 (CO_2 from Fuel Combustion, Bottom-Up Approach) is applied in calculating CO_2 emissions from industrial and residential biomass fuel burning. The fuel categories this time are the various types of biomass fuels but the steps to be followed are just those of Section 1.2.2. Complete worksheet 1-5A, CO_2 from Residential and Industrial Biomass Fuels, for this memo item.

1.6.2 CO_2 FROM INTERNATIONAL BUNKERS

CO_2 emissions from marine and air transport are computed by looking at the fuel allocation for international bunkers in the top-down approach. Use **Worksheet 1-5B** for the following step-by-step calculation.

Worksheet 1-5B, Sheet 1 of 2

1 For each fuel type, input in Column A the fuel quantity transported internationally by marine and aviation vehicles (in ktoe). Note that these are the same data in Column D of **Worksheet 1-1A**.

2 Enter the appropriate conversion factor (41.87 TJ/ktoe) in Column B to convert to TJ.

3 In column C, compute the quantities delivered (in TJ) by multiplying Columns A and B.

4 Input the carbon emission factors (in t C/TJ) for each fuel type in Column D. (Refer to Table 1-2 of the Reference Manual.)

5 In column E, get the carbon content (in t of C) by multiplying Columns C and D.

6 Convert units to Gg C by multiplying the values in Column E by 10^{-3}.

Worksheet 1-5B, Sheet 2 of 2

7 Enter the fraction of carbon stored for each fuel type in Column G.

8 Compute the amount of carbon stored (in Gg of C) by multiplying Column F with Column G in Column H.

9 In Column M, subtract Column H from Column F to get the net carbon emissions.

Step 5 Estimating the Actual Carbon Emissions of Each Fuel Type

10 Enter the fraction of carbon oxidized in Column J. The default IPCC values listed in Table 1-3 of the Reference Manual are used.

11 Multiply Columns I and J to get the actual carbon emissions (in Gg of C).

Step 6 Calculating for the Actual CO_2 Emissions from International Bunkers

12 Finally, in Column L, compute the actual CO_2 emissions (in Gg) by multiplying Column K by the molecular ratio 44/12.

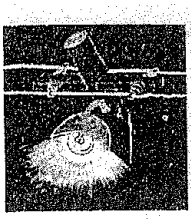
1.7 Conclusion

As summary of all the calculations, the following worksheets are completed to provide an overall picture of the energy-related GHG emissions.

a) Submodule: CO_2 from Fuel Combustion Bottom-Up Approach: An Overview, Worksheet 1-SA.

b) Submodule: National Greenhouse Gas Inventory from the Energy Sector, Worksheet 1-SB.

These two worksheets provide (a) a summary of the energy-related CO_2 emissions per fuel type and (b) an overview of the national total of the GHG and SO_2 emissions from the Energy sector.



ENERGY SECTOR

Worksheets

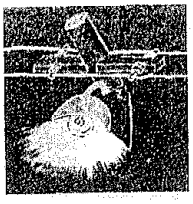
CO_2 FROM FUEL COMBUSTION: TOP-DOWN APPROACH

	Energy
	CO_2 from Energy Sources (Top-Down Approach)
	1-1A
	1 of 3

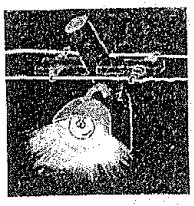
			STEP 1					
			A	B	C	D	E	F
Fuel Types			Production (ktoe)	Imports (ktoe)	Exports (ktoe)	International Bunkers (ktoe)	Stock Change (ktoe)	Apparent Consumption (ktoe)
								F=(A+B-C-D-E)
Liquid Fossil	Primary Fuels	Crude Oil	256.38	11,884.58	176.50		149.16	11,815.30
	Secondary Fuels	Gasoline (premium)		378.80	23.82		-18.06	373.04
		Kerosene		83.48			-5.92	89.40
		Diesel		1,976.35		30.65	-142.54	2,088.24
		Fuel Oil		1,069.05	47.65	62.00	-53.40	1,012.79
		LPG		397.83			7.70	390.14
		Avturbo		30.04		450.93		-420.89
		Naptha			548.85		-8.52	-540.33
		Asphalt					-3.22	3.22
		Avgas		2.89			-0.98	3.87
		Others		17.44		0.17	-16.72	33.99
		Liquid Fossil Totals	256.38	15,840.45	796.82	543.75	-92.50	14,848.76
Solid Fossil	Primary Fuels	Coal	696.00	534.00			-25.00	1,255.00
		Solid Fossil Totals	696.00	534.00	0.00	0.00	-25.00	1,255.00
		TOTAL	952.38	16,374.45	796.82	543.75	-117.50	16,103.76
Biomass Total								
		Solid Biomass						12,004.43

	Energy
	CO_2 from Energy Sources (Top-Down Approach)
	1-1A
	2 of 3

			STEP 2			STEP 3	
			G	H	I	J	K
Fuel Types			Conversion Factor (TJ/ktoe)	Apparent Consumption (TJ)	Carbon Emission Factor (t C/TJ)	Carbon Content (t C)	Carbon Content (Gg C)
				H=(FxG)		J=(HxI)	K=(Jx10^{-3})
Liquid Fossil	Primary Fuels	Crude Oil	41.87	494,682.98	20.00	9,893,659.66	9,893.66
	Secondary Fuels	Gasoline	41.87	15,618.37	18.90	295,187.12	295.19
		Kerosene	41.87	3,743.11	19.60	73,364.97	73.36
		Diesel	41.87	87,430.22	20.20	1,766,090.51	1,766.09
		Fuel Oil	41.87	42,403.49	21.10	894,713.64	894.71
		LPG	41.87	16,334.18	17.20	280,947.95	280.95
		Avturbo	41.87	-17,621.71	21.10	-371,818.11	-371.82
		Naptha	41.87	-22,622.55	20.00	-452,451.08	-452.45
		Asphalt	41.87	135.00	22.00	2,970.09	2.97
		Avgas	41.87	161.86	18.90	3,059.19	3.06
		Others	41.87	1,422.98	20.00	28,459.58	28.46
		Liquid Fossil Totals		621,687.94		12,414,183.53	12,414.18
Solid Fossil	Primary Fuels	Coal	41.87	52,544.34	26.20	1,376,661.71	1,376.66
		Solid Fossil Totals		52,544.34		1,376,661.71	1,376.66
		TOTAL		674,232.28			
Biomass Total							
		Solid Biomass	41.87	502,601.48	29.90	15,027,784.31	15,027.78



Module	Energy						
Submodule	CO_2 from Energy Sources (Top-Down Approach)						
Worksheet	1-1A						
Sheet	3 of 3						
				L	M	N	O	P
Fuel Types				Carbon Stored (Gg C)	Net Carbon Emissions (Gg C)	Fraction of Carbon Oxidized	Actual Carbon Emissions (Gg C)	Actual CO_2 Emissions (Gg CO_2)
					M=(K-L)		O=(MxN)	P=(Ox[44/12])
Liquid Fossil	Primary Fuels	Crude Oil			9,893.66	0.99	9,794.72	35,913.98
	Secondary Fuels	Gasoline			295.19	0.99	292.24	1,071.53
		Kerosene			73.36	0.99	72.63	266.31
		Diesel			1,766.09	0.99	1,748.43	6,410.91
		Fuel Oil			894.71	0.99	885.77	3,247.81
		LPG			280.95	0.99	278.14	1,019.84
		Avturbo			-371.82	0.99	-368.10	-1,349.70
		Naptha			-452.45	0.99	-447.93	-1,642.40
		Asphalt		2.97	0.00	0.99	0.00	0.00
		Avgas			3.06	0.99	3.03	11.10
		Others			28.46	0.99	28.17	103.31
			Liquid Fossil Totals	2.97	12,411.21		12,287.10	45,052.71
Solid Fossil	Primary Fuels	Coal			1,376.66	0.98	1,349.13	4,946.80
			Solid Fossil Totals		1,376.66		1,349.13	4,946.80
							TOTAL	49,999.51
Biomass Total								
		Solid Biomass			15,027.78	0.88	13,224.45	48,489.65



CO_2 EMISSIONS FROM FUEL COMBUSTION: BOTTOM-UP APPROACH

Sector:	Energy
Source Category:	CO_2 from Fuel Combustion by Source Categories (Bottom-Up Approach)
Worksheet:	1-1B Step by Step Calculations
Sheet:	1 of 10 (Energy Industries)

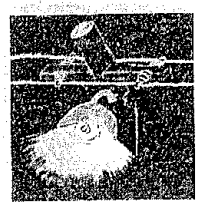
	STEP 1	STEP 2		STEP 3		
Fuel Type and Subsector	A Consumption (ktoe)	B Conversion Factor (TJ/ktoe)	C Consumption (TJ)	D Carbon Emission Factor (t C/TJ)	E Carbon Content (t C)	F Carbon Content (Gg C)
			C=(AxB)		E=(CxD)	F=(Ex10^{-3})
Energy Industries						
Coal	603.35	41.67	25,260.99	26.20	661,838.05	661.84
Diesel	1,476.69	41.87	61,826.19	20.20	1,248,889.06	1,248.89
Fuel Oil	2,660.06	41.87	111,371.22	21.10	2,349,932.66	2,349.93
Avturbo	0.12	41.87	4.87	21.10	102.80	0.10
Naptha	1.75	41.87	73.11	20.00	1,462.20	1.46
Asphalt	0.00	41.87	0.00	22.00	0.00	0.00
Avgas	0.00	41.67	0.00	18.90	0.00	0.00
Others	6.85	41.67	286.86	20.00	5,737.23	5.74
		TOTAL CONSUMPTION	198,823.24			

Sector:	Energy
Source Category:	CO_2 from Fuel Combustion by Source Categories (Bottom-Up Approach)
Worksheet:	1-1B Step by Step Calculations
Sheet:	2 of 10 (Energy Industries)

	STEP 2			STEP 3		STEP 4
Fuel Type and Subsector	G Fraction of Carbon Stored	H Carbon Stored (Gg C)	I Net Carbon Emissions (Gg C)	J Fraction of Carbon Oxidised	K Actual Carbon Emissions	L Actual CO_2 Emissions
		H=(FxG)	I=(F-H)		K=(IxJ)	L=(Kx[44/12])
Energy Industries						
Coal	0.00	0.00	661.84	0.98	648.60	2,378.20
Diesel	0.00	0.00	1,248.89	0.99	1,236.40	4,533.47
Fuel Oil	0.00	0.00	2,349.93	0.99	2,326.43	8,530.26
Avturbo	0.00	0.00	0.10	0.99	0.10	0.37
Naptha	0.00	0.00	1.46	0.99	1.45	5.31
Asphalt	0.00	0.00	0.00	0.99	0.00	0.00
Avgas	0.00	0.00	0.00	0.99	0.00	0.00
Others	0.50	2.87	2.87	0.99	2.84	10.41
					TOTAL CO_2 EMISSIONS	15,458.02

Sector:	Energy
Source Category:	CO_2 from Fuel Combustion by Source Categories (Bottom-Up Approach)
Worksheet:	1-1B Step by Step Calculations
Sheet:	3 of 10 (Manufacturing Industries)

	STEP 1	STEP 2		STEP 3		
FUEL TYPE AND SUBSECTOR	A Consumption (ktoe)	B Conversion Factor (TJ/ktoe)	C Consumption (TJ)	D Carbon Emission Factor (t C/TJ)	E Carbon Content (t C)	F Carbon Content (Gg C)
			C=(AxB)		E=(CxD)	F=(Ex10^{-3})
Manufacturing Industries						
Coal	639.66	41.87	26,781.20	26.20	701,667.56	701.67
Kerosene	29.00	41.87	1,214.10	19.60	23,796.29	23.80
Diesel	439.39	41.87	18,396.52	20.20	371,609.72	371.61
Fuel Oil	1,560.84	41.87	65,349.13	21.10	1,378,866.61	1,378.87
LPG	6.96	41.87	291.29	17.20	5,010.17	5.01
Naptha	0.00	41.87	0.00	20.00	0.00	0.00
		TOTAL CONSUMPTION	112,032.24			
Memo Items:						
Wood/Wood Waste	134.92	41.87	5,648.91	29.90	168,902.31	168.90
Charcoal		41.87	0.00	29.90	0.00	0.00
Bagasse	1,495.00	41.87	62,592.66	29.90	1,871,520.53	1,871.52
Agriwaste	4,284.63	41.87	179,389.09	29.90	5,363,733.84	5,363.73
Other Solid Biomass		41.87	0.00	29.90	0.00	0.00
		Total Biomass	247,630.66			



	Energy					
	CO_2 from Fuel Combustion by Source Categories (Bottom-Up Approach)					
	1-1B Step by Step Calculations					
	4 of 10 (Manufacturing Industries)					
	Step 1			Step 2		Step 3
FUEL TYPE AND SUBSECTOR	G Fraction of Carbon Stored	H Carbon Stored (Gg C)	I Net Carbon Emissions (Gg C)	J Fraction of Carbon Oxidised	K Actual Carbon Emissions	L Actual CO_2 Emissions
		H=(FxG)	I=(F-H)		K=(IxJ)	L=(Kx[44/12])
Manufacturing Industries						
Coal	0.00	0.00	701.67	0.98	687.63	2,521.33
Kerosene	0.00	0.00	23.80	0.99	23.56	86.38
Diesel	0.00	0.00	371.61	0.99	367.89	1,348.94
Fuel Oil	0.00	0.00	1,378.87	0.99	1,365.08	5,005.29
LPG	0.00	0.00	5.01	0.99	4.96	18.19
Naptha	0.00	0.00	0.00	0.99	0.00	0.00
					TOTAL CO_2 EMISSIONS	8,980.12
Memo Items:						
Wood/Wood Waste	0.00	0.00	168.90	0.99	167.21	613.12
Charcoal	0.00	0.00	0.00	0.99	0.00	0.00
Bagasse	0.00	0.00	1,871.52	0.99	1,852.81	6,793.62
Agriwaste	0.00	0.00	5,363.73	0.99	5,310.10	19,470.35
Other Solid Biomass	0.00	0.00	0.00	0.99	0.00	0.00
					Total Biomass	26,877.09

	Energy					
	CO_2 from Fuel Combustion by Source Categories (Bottom-Up Approach)					
	1-1B Step by Step Calculations					
	5 of 10 (Transport)					
	Step 1		Step 2		Step 3	
FUEL TYPE AND SUBSECTOR	A Consumption (ktoe)	B Conversion Factor (TJ/ktoe)	C Consumption (TJ)	D Carbon Emission Factor (t C/TJ)	E Carbon Content (t C)	F Carbon Content (Gg C)
			C=(AxB)		E=(CxD)	F=(Ex10^{-3})
Road Transport						
Gasoline	1,767.37	41.67	73,996.36	18.90	1,398,531.14	1,398.53
Kerosene	1.72	41.67	71.98	19.60	1,410.90	1.41
Diesel	2,886.90	41.67	120,870.18	20.20	2,441,577.60	2,441.58
Fuel Oil	5.68	41.67	236.02	21.10	5,022.20	5.02
		Subtotal	195,176.54			
Domestic Marine						
Gasoline	0.54	41.67	22.42	18.90	423.77	0.42
Kerosene	1.21	41.67	50.64	19.60	996.49	1.00
Diesel	110.08	41.67	4,608.79	20.20	93,097.53	93.10
Fuel Oil	278.13	41.67	11,644.78	21.10	245,704.38	245.70
		Subtotal	16,326.83			
Domestic Aviation						
Avturbo	182.22	41.67	7,629.29	21.10	160,978.11	160.98
Avgas	6.36	41.67	267.12	18.90	5,048.55	5.05
		Subtotal	7,896.41			
		TOTAL CONSUMPTION	219,399.78			