THE INVENTORY OF GREENHOUSE GASES (GHG) IN MALAYSIA

by

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The need for a GHG inventory

- **To compare the relative contribution of different emission sources and different GHG to climate change.**

- **To ascertain the portion of emissions attributable to individual countries and different regions of the world.**

- **To assess emission differences among different technologies in order to evaluate the cost - effectiveness of alternative control technologies.**

- **To evaluate the effectiveness of possible mitigation strategies**

- **The first GHG inventory exercise carried out in Malaysia entailed three (3) priority greenhouse gases i.e. carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).**
- **The 1995 IPCC guidelines were used in estimating the emissions of the GHG.**
- **In accordance with the consensus reached concerning the non-Annex 1 countries at the Conference of Parties 2 (COP2), the base year selected was 1994.**

- **CO_2 emissions were estimated from major sources of the following sectors:**

a) Energy - fuel combustion

b)Industrial Processes - essentially, cement manufacturing

Minor sources include the following sectors:

c) Waste - industrial wastewater treatment

d) Land Use Change and Forestry (LUCF) - forest and grassland conversion

- **In addition, CO_2 sinks were estimated from the LUCF sector, namely changes in forest and woody biomass stocks**

CH_4 emissions were estimated from the following sectors:

a) Energy

- **fugitive emissions from coal and mining**
- **fugitive emissions from oil and natural gas systems**
- **burning of traditional biomass fuels**

b) Agriculture

- domestic livestock enteric fermentation and manure management
- flooded rice fields
- burning of agricultural residues

c) Waste

- landfills
- domestic and commercial wastewater treatment
- industrial wastewater treatment

d) Land Use Change and Forestry

- on-site burning of forest

N_2O emissions were estimated from the following sectors:

a) Energy

- **burning of traditional biomass fuel**

b) Agriculture

- **burning of agricultural residues**

c) Land Use Change and Forestry

- **on-site burning of forest**

The procedure in compiling the inventory involves the following steps:

- **Assembling of data**
- **Selection of appropriate emission factors**
- **Aggregating/Transforming of data into a standard format using appropriate software and guidelines**
- **Reporting and peer review**
- **Final national inventory**

- **Malaysia's GHG emissions totalled the equivalent of 144 million tonnes of CO_2 in 1994. Net emissions, after accounting for sinks, totalled the equivalent of 76 million tonnes. On a per capita basis, the net emissions were equivalent to 3.7 tonnes.**

Table 1: Summary Of National Greenhouse Gas Emissions And Removal In 1994

Source & Sink Categories	1994 CO_2 Gg	CO_2 %	CH_4 Gg	CH_4 %	N_2O Gg	N_2O %
1. Energy						
Fuel combustion	84,415	86.7				
Fugitive emissions from coal mining			0.13	0.006		
Fugitive emissions from oil & gas systems			593	26.6		
Burning of traditional biomass fuels			42	1.9	0.35	86.4
2. Industrial Process						
Cement production	4,973	5.1				
3. Agriculture						
Domestic livestock enteric fermentation and manure management			75	3.4		
Flooded rice fields			252	11.3		
Burning of agricultural residues			2.3	0.1	0.054	13.3
4. Waste						
Landfills			1,043	46.8		
Domestic & commercial wastewater treatment			3.5	0.16		
Industrial wastewater treatment	318	0.3	220	9.8		
5. Land Use Change and Forestry						
Changes in forest and other woody biomass stock (Sink)	*-68,717*	-				
Forest and grassland conversion	7,636	7.8				
On-site burning of forest			0.13	0.006	0.001	0.3
Total (Emissions only)	97,342	100	2,231	100	0.405	100
Net Total (After Subtracting Sink)	28,625					

Note: i) (-) denotes sink
ii) Total CO_2 emissions from international bunkers: 785.55 Gg. (Has already been substracted from total CO2 emissions in the energy sector)

Table 2: Emissions And Removal Of Greenhouse Gases For Each Sector In 1994

Sector		Emissions (Gg) A	GWPs B	CO_2 Equivalent (Gg) C=(A x B)
Energy	CO_2	84,415	1	84,415
	CH_4	635	21	13,335
	N_2O	0.35	290	102
Sub-total				97,852
Industrial Processes	CO_2	4,973	1	4,973
Sub-total				4,973
Agriculture	CH_4	329	21	6,909
	N_2O	0.054	290	16
Sub-total				6,925
Land Use Change and Forestry	$CO_{2(Emission)}$	7,636	1	7,636
	$CO_{2\ (Sink)}$	*-68,717*	*1*	*-68,717*
	CH_4	0.13	21	3
	N_2O	0.001	290	0.3
Sub-total				7,639
Waste	CO_2	318	1	318
	CH_4	1,267	21	26,607
Sub-total				26,925
Total (Emissions only)				144,314
Net Total (After Subtracting Sink)				75,597

			MODULE	ENERGY					
			SUBMODULE	CO_2 FROM ENERGY SOURCES (REFERENCE APPROACH)					
			WORKSHEET	1-1					
			SHEET	1 OF 2					
				A	B	C	D	E	F
				Production	Imports	Exports	International Bunkers	Stock Change	Statistical Discrepancy
	FUEL TYPES								
Liquid Fossil	Primary Fuels	Crude Oil		32798	1566	19726		229	804
		Natural Gas Liquids							
	Secondary Fuels	Gasoline			1925			75	
		Aviation turbine fuel (ATF)			153	106		-3	
		Kerosene			9	584		52	
		Gas/Diesel Oil			1704	816	22	43	
		Fuel Oil			2561	1923	222	63	
		LPG			379	262		4	
		Non-Energy			758	1403	2	46	
		Aviation Gas			3				
		Others			574				
		LNG				12502			
Solid Fossil Total		Coke and Coal		89	1351	40		-163	
Gaseous Fossil		Natural Gas (Dry)		28335		1589			
(Source: National energy Balance, Malaysia 1980-1995)									

G	H	I	J	K	L
Apparent Consumption	Conversion Factor (TJ/unit)	Apparent Consumption (TJ)	Carbon Emission factor (t C/TJ)	Carbon Content (tC)	Carbon Content (Gg C)
G=(A+B-C-D-E-F)		I=(GxH)		K=(IxJ)	L=(Kx10^{-3})
13605	41.87	569614	20.00	11392283	11392
1850	41.87	77456	18.90	1463915	1464
50	41.87	2093	19.50	40821	41
-627	41.87	-26251	19.60	-514524	-515
823	41.87	34457	20.20	696039	696
353	41.87	14779	21.10	311845	312
113	41.87	4731	17.20	81375	81
-693	41.87	-29015	20.00	-580290	-580
3	41.87	126	18.90	2374	2
574	41.87	24032	20.00	480645	481
-12502	41.87	-523434	17.20	-9003060	-9003
1563	41.87	65440	29.50	1930471	1930
26746	41.87	1119802	15.30	17132963	17133

			MODULE	ENERGY			
			SUBMODULE	CO_2 FROM ENERGY SOURCES (REF. APP.)			
			WORKSHEET	1-1			
			SHEET	2 OF 2			
				M	N	O	P
				Net Carbon Emissions (Gg)	Fraction of Carbon Oxidised	Actual Carbon Emissions (Gg C)	Actual CO_2 Emissions (Gg CO_2)
	FUEL TYPES					O=(MxN)	P=(Ox[44/12])
Liquid Fossil	Primary Fuels	Crude Oil		11392.28	0.990	11278	41354
		Natural Gas Liquids					
	Secondary Fuels	Gasoline		1464	0.990	1449	5314
		Aviation turbine fuel (ATF)		41	0.990	40	148
		Kerosene		-515	0.990	-509	-1868
		Gas/Diesel Oil		696	0.990	689	2527
		Fuel Oil		312	0.990	309	1132
		LPG		81	0.990	81	295
		Non-Energy		-580	0.990	-574	-2106
		Aviation Gas		2	0.995	2	9
		Others		481	0.990	476	1745
		LNG		-9003	0.990	-8913	-32681
Solid Fossil Total		Coke and Coal		1930	0.980	1892	6937
Gaseous Fossil		Natural Gas (Dry)		16887	0.995	16803	61610
Total							**84415**
(Source: National energy Balance, Malaysia 1980-1995)							

Table 3: CO_2 Emissions (Gg) from Fuel Combustion based on Total Final Use in 1994

	Natural Gas	Aviation Gas	LPG	Motor Petrol	ATF	Kerosene	Diesel Oil	Fuel Oil	Coal & Coke	TOTAL	%
Residential & Commercial	493	0	1,833	0	0	438	71	180	0	3,014	7
Industries	1,131	0		34	0	15	9,413	4,222	2,681	18,083	41
Transportation	12	14	588	11,855	2,884	0	6,549	0	1	21,375	49
Agriculture	0	0	0	5	4	0	1,293	61	0	1,296	3
			0	0	0			3	0		
TOTAL	1,636	14	2,421	11,889	2,884	453	17,326	4,464	2,681	43,768	100

Note: ATF = Aviation Turbine Fuel LPG = Liquefied Petroleum Gas

Table 4: Greenhouse Gas (GHG) Emissions Of Selected Countries

Country	Year	GHG emissions (million tonnes)
Malaysia	1990	138
	1994	144
Thailand	1990	225
Australia	1990	572
Japan	1990	1,216
	1994	1,276
United States of America	1990	5,896
	1994	6,131

Note: The emissions are expressed as CO_2 equivalent, and include the major GHGs i.e. CO_2, CH_4 and N_2O.

Table 5: CO_2 Emissions Per Capita Of Selected Countries (1996)

Country	tonnes CO_2/capita
Philippines	0.91
Indonesia	1.21
Thailand	2.92
Malaysia	5.31
Japan	9.36
United Kingdom	9.91
Australia	10.57
Canada	15.67
United States	20.05
Singapore	21.45
Brunei	27.92

Source: International Energy Agency, 1996

Projection of GHG Emissions

- **Pertinent information was extracted from a country study of Malaysia (1996) on efficiency - oriented and environmentally - constrained alternative energy strategy scenarios (EASES)**

- **Three plausible scenarios were considered:**

a) Business-as-usual (BAU)

b) Efficiency-oriented (EFF)

c) Environmentally-constrained with efficiency (ENV)

Table 7: Projected CO_2 emission by scenario (2000-2020)

	Actual (Gg)		Projected (Gg)		
	1994	1995	2000	2010	2020
Business-As-Usual (BAU)	84415.25	95235.75	132990	211662	341491
Efficiency-Oriented (EFF)	84415.25	95235.75	132561	198315	294470
Environmentally-Constrained (ENV)	84415.25	95235.75	132561	194271	293755

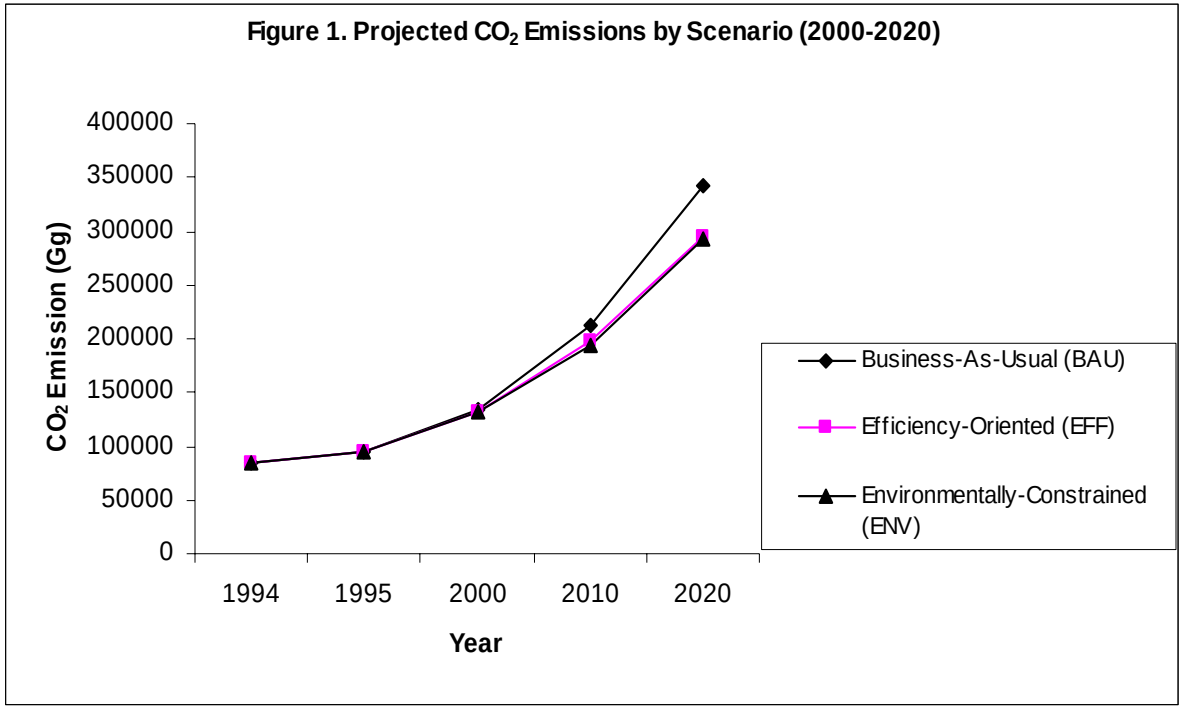
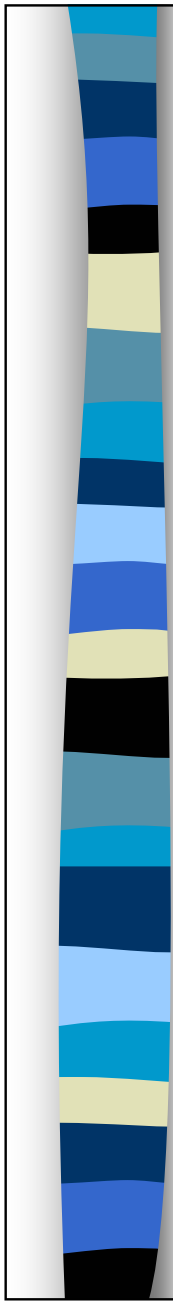


Figure 1. Projected CO_2 Emissions by Scenario (2000-2020)
400000
350000
300000
250000
200000
150000
100000
50000
0
CO_2 Emission (Gg)
1994
1995
2000
2010
2020
Year
Business-As-Usual (BAU)
Efficiency-Oriented (EFF)
Environmentally-Constrained (ENV)

Difficulties and uncertainties encountered in the course of preparing the GHG inventory include the following:

- **Database collection format**
- **Categorization of forests**
- **Emission factors**
- **Forest fires**
- **Defining certain terminologies**



THANK YOU