GHG Inventory in the Energy Sector and Industrial Processes

5th Workshop on GHG Inventories in Asia (WGIA5)
6-7 September 2007

Save Energy for Our Future Generation

Presentation Outline

- Identification of GHG Sources
- Scope of the Inventory
- Steps Taken in Preparing the Inventory
- Data Estimation and Approach
- Key Category Analysis
- Constraints and Problem Encountered
- Further Refinement in GHG Inventory

GHG Sources

- Emissions are estimated from the following categories/sources:
  - Energy Sector
    - Fuel Combustion
    - Fugitive Emissions from Fuel (Coal Mining and Oil & Gas System)
    - Burning of biomass fuel in energy industries

  - Industrial Processes
    - Production and Consumption of Mineral products, Chemical products, Metal, Halocarbons, Sulphur Hexaflouride and other products in Malaysian industries
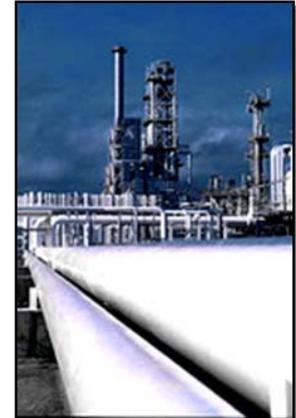
Identification of GHG Sources

Gases Covered:

- Carbon dioxide(CO_2)
- Methane (CH_4)
- Nitrous Oxide (N_2O)
- Hydrofluorocarbon (HFC)
- Sulphur Hexafluoride (SF_6)
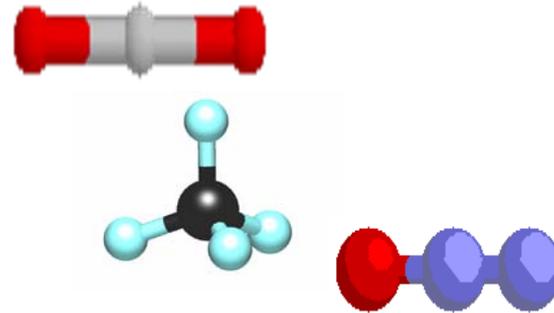
- Base Year: 2000

- Guidelines: Revised 1996 IPCC Guidelines Workbook, Reference Manual and IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories

Scope of the Inventory

Sectors Covered:

i. Energy Sector (Fuel Combustion)

- Power Industry
- Transport (Road, Rail, Navigation, Aviation)
- Industry
- Residential
- Commercial
- Agriculture/Forestry/Fishery
- Others (Transformation and Military Road Transport)

ii. Industrial Processes

- Metal (Iron & Steel)
- Chemical (Ammonia, Nitric Acid, Carbide, Other petrochemical products)
- Mineral (Cement, Lime, Limestone and Dolomite)
- Consumption of Hydrofluorocarbon (HFC)
- Consumption of Sulfur Hexafluoride (SF_6)

Steps Taken in Preparing the Inventory

1. Established Method

4. Inventory Report and Recommendations

Stakeholder Workshop

2. Data Listing and Collection

3. Data Input to IPCC Worksheet

STAGE 1

STAGE 2
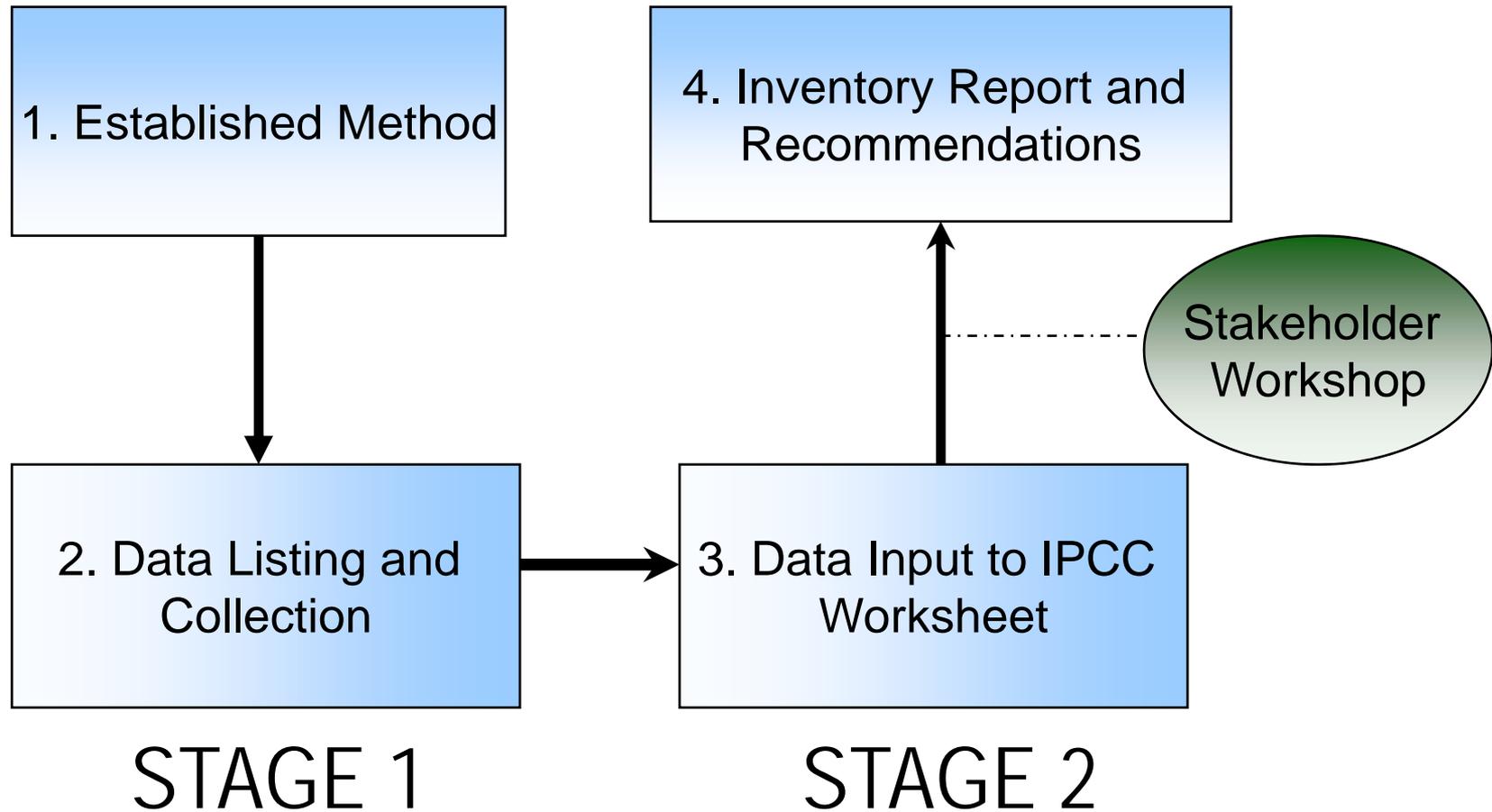
Data Collection and Management for Energy Sector

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Data Source

1. ## National Energy Balance : Secondary Data

   - which document the data on Malaysia's primary production of energy supply and final demand of energy
   - it reports a number representing a total amount of fuel use which based on fuel type

2. ## Primary data

   - which taken from respective agencies e.g. Malaysia Railways Limited (KTMB) and Malaysia International Shipping Corporation (MISC)
   - to fulfill the data requirement in the IPCC Worksheet e.g. Transport – Road, Rail, Navigation, Aviation

Data Estimation and Approach in Transport Sector

- Proportion of data based on the following percentage
- The proportion is based on the complete data set of segregation of fuel from the oil supplier

Transport Sub-sector	Percentage (%)				
	Diesel	Petrol	Natural Gas	Jet Kerosene	Residual Fuel Oil
Road	74%	100%	100%		
Rail	1%				
National Navigation	25%				100%
Domestic Aviation				100%	

IPCC Worksheet: Transport Sector

	ENERGY						ENERGY					
MODULE	ENERGY						ENERGY					
SUBMODULE	CO$_2$ FROM FUEL COMBUSTION BY SOURCE CATEGORIES (TIER 1)						CO$_2$ FROM FUEL COMBUSTION BY SOURCE CATEGORIES (TIER 1)					
WORKSHEET	1-2 STEP BY STEP CALCULATIONS						1-2 STEP BY STEP CALCULATIONS					
SHEETS	5 OF 16 TRANSPORT						6 OF 16 TRANSPORT					
COUNTRY	Malaysia						Malaysia					
YEAR	2000						2000					

TRANSPORT	STEP 1 A Consumption	STEP 2 B Conversion Factor (TJ/Unit)	C Consumption (TJ) C=(AxB)	STEP 3 D Carbon Emission Factor (t C/TJ)	E Carbon Content (t C) E=(CxD)	F Carbon Content (Gg C) F=(E/1000)	STEP 4 G Fraction of Carbon Stored	H Carbon Stored (Gg C) H=(FxG)	I Net Carbon Emissions (Gg C) I=(F-H)	STEP 5 J Fraction of Carbon Oxidised	K Actual Carbon Emissions (Gg C) K=(IxJ)	STEP 6 L Actual CO$_2$ Emissions (Gg CO$_2$) L=(Kx[44/12])
Domestic Aviation [a]												
Jet Kerosene	1574	41.84	65,856.16	19.5	1,284,195.12	1,284.20			1,284.20	0.99	1,271.35	4,661.63
		Subtotal	65,856.16								Subtotal	4,661.63
Road Transport												
Natural Gas	7	41.84	292.88	15.3	4,481.06	4.48			4.48	0.995	4.46	16.35
Gasoline	6378	41.84	266,855.52	18.9	5,043,569.33	5,043.57			5,043.57	0.99	4,993.13	18,308.16
Gas/Diesel Oil	3016	41.84	126,189.44	20.2	2,549,026.69	2,549.03			2,549.03	0.99	2,523.54	9,252.97
		Subtotal	393,337.84								Subtotal	27,577.47
Rail Transport												
Gas/Diesel Oil	27	41.84	1,135.54	20.2	22,937.86	22.94			22.94	0.99	22.71	83.26
		Subtotal	1,135.54								Subtotal	83.26
National Navigation [a]												
Gas/Diesel Oil	1060	41.84	44,350.40	20.2	895,878.08	895.88			895.88	0.99	886.92	3,252.04
Residual Fuel Oil	4	41.84	167.36	21.1	3,531.30	3.53			3.53	0.99	3.50	12.82
		Subtotal	44,517.76								Subtotal	3,264.86
		Total Transport [a]	504,847.30								Total Transport [a]	35,587.22

- Assumptions
  - Stationary: 5%
  - Mobile: 95%
  - Based on discussion with Ministry of Agriculture
  - Data Source: National Energy Balance Report

MODULE	ENERGY						ENERGY					
SUBMODULE	CO_2 FROM FUEL COMBUSTION BY SOURCE CATEGORIES (TIER						CO_2 FROM FUEL COMBUSTION BY SOURCE CATEGORIES (TIER 1)					
WORKSHEET	1-2 STEP BY STEP CALCULATIONS						1-2 STEP BY STEP CALCULATIONS					
SHEETS	13 OF 16 AGRICULTURE / FORESTRY / FISHING						14 OF 16 AGRICULTURE / FORESTRY / FISHING					
COUNTRY	Malaysia						Malaysia					
YEAR	2000						2000					
	STEP 1	STEP 2		STEP 3			STEP 4			STEP 5		STEP 6
	A	B	C	D	E	F	G	H	I	J	K	L
AGRICULTURE /	Consumption	Conversion	Consumption	Carbon Emission	Carbon	Carbon	Fraction of	Carbon Stored	Net Carbon	Fraction of	Actual Carbon	Actual CO_2
FORESTRY / FISHING		Factor	(TJ)	Factor	Content	Content	Carbon Stored (a)	(Gg C)	Emissions	Carbon Oxidised	Emissions	Emissions
		(TJ/Unit)		(t C/TJ)	(t C)	(Gg C)			(Gg C)		(Gg C)	(Gg CO_2)
			C=(AxB)		E=(CxD)	F=(E/1000)		H=(FxG)	I=(F-H)		K=(IxJ)	L=(Kx[44/12])
Mobile												
Gasoline	2.85	41.84	119.24	18.9	2,253.71	2.25			2.25	0.99	2.23	8.18
Gas/Diesel Oil	248.9	41.84	10,413.98	20.2	210,362.32	210.36			210.36	0.99	208.26	763.62
Residual Fuel Oil	11.4	41.84	476.98	21.1	10,064.19	10.06			10.06	0.99	9.96	36.53
		Total Mobile	**11,010.20**								**Total Mobile**	**808.33**
Stationary												
Gasoline	0.15	41.84	6.28	18.9	118.62	0.12			0.12	0.99	0.12	0.43
Gas/Diesel Oil	13.1	41.84	548.10	20.2	11,071.70	11.07			11.07	0.99	10.96	40.19
Residual Fuel Oil	0.6	41.84	25.10	21.1	529.69	0.53			0.53	0.99	0.52	1.92
		Total Stationary	**579.48**								**Total Stationary**	**42.54**

Data Collection and Management for Industrial Processes

- Nitric Acid Production: 75,392 tonnes
- **Emission factor**: 8.79 kg N_2O/t HNO_3 (actual measurement)

MODULE	INDUSTRIAL PROCESSES		
SUBMODULE	NITRIC ACID PRODUCTION		
WORKSHEET	2-7		
SHEET	I OF 1 N_2O AND NO_x EMISSIONS		
COUNTRY	Malaysia		
YEAR	2000		
A Amount of Nitric Acid Produced (t)	B Emission Factor (kg pollutant/t nitric acid produced)	C Pollutant Emitted (kg)	D Pollutant Emitted (Gg)
		C = (A x B)	D = C/1 000 000
75,392	N_2O 8.79	662,695.68	N_2O 0.66
	NO_x	0.00	NO_x 0.00

Key Category Analysis – Sectoral Approach

CO_2 Emissions from the Energy Sector

- Agriculture/Forestry/Fishing, 851Gg 1%
- Residential, 1,820Gg 2%
- Commercial, 2,127Gg 2%
- Transport, 35,587Gg 30%
- Others, 17,145Gg 14%
- Energy Industries, 37,126Gg 31%
- Manufacturing Industries and Construction, 24,150Gg 20%
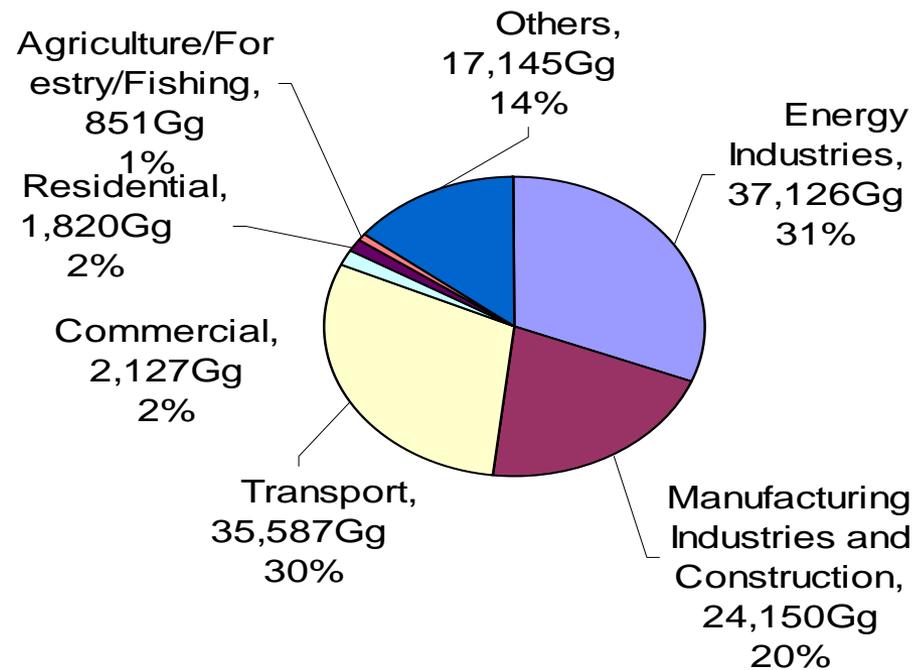
TOTAL: 118,806 $GgCO_2$

Key Category Analysis – Energy Sector

Sources	2000					
	CO_2		CH_4		N_2O	
Categories	Gg	%	Gg	%	Gg	%
Total National Emissions	**168,037**		**1,202.21**		**0.69**	
Energy Sector	**133,529**		**1,198**		**0.03**	
1. Reference Approach	133,529					
2. Sectoral Approach	118,806	100				
a. Energy Industries	37,126	31				
i. Autoproducers	1,799	5				
ii. Power	35,327	95				
b. Manufacturing Industries and Construction	24,150	20				
i. Manufacturing	17,790	74				
ii. Mining	268	1				
iii. Construction	6,092	25				
c. Transportation	35,587	30				
i. Road	27,577	78				
ii. Rail	83	0.2				
iii. Aviation	4,662	13				
iv. Navigation	3,265	9				

Sources	2000					
	CO_2		CH_4		N_2O	
d. Other Sectors	4,797	5				
i. Residential	1,820	38				
ii. Commercial	2,127	44				
iii. Agriculture	804	17				
iv. Fisheries	38	0.8				
v. Forestry	8	0.2				
e. Others	17,145	14				
i. Gas Transformation and Losses	17,102	99				
ii. Military Road	43	0.3				
a. Fugitive Emissions from Fuel			1,198	100		
i. Coal Mining and Handling			0.28	1		
ii. Oil and Gas System			1,197	99		
b. Emission from Biomass Fuels					0.03	100

Key Category Analysis – Industrial Processes

Sources	2000					
	CO$_2$		CH$_4$		N$_2$O	
Industrial Processes	**17,254**	**100**	**4.21**	**100**	**0.66**	**100**
a. Mineral Products	9,670	56				
i. Cement Production	6,617	68				
ii. Lime Production	153	2				
iii. Limestone and Dolomite Use	2,901	30				
b. Chemical Industry	1,192	7	4.21	100	0.66	100
i. Ammonia Production	1,176	99				
ii. Nitric Acid Production					0.66	100
iii. Carbide Production	16	1				
iv. Petrochemicals			4.21	100		
c. Metal Production	6,392	37				
i. Iron and Steel Production						

Key Category Analysis – Industrial Processes

Sources	HFC		SF_6	
Categories	Gg	%	Gg	%
Total National Emissions	0.2	100	0.02	100
Industrial Processes	0.2	100	0.02	100
a. Consumption of HFC 134a for Mobile Air Conditioning (MAC)	0.2	100		
b. Consumption of SF_6			0.02	100

Key Category Analysis – Results

Sectors		Emissions (Gg) A	GWPs B	CO$_2$ Equivalent (Gg) C=(A x B)
Energy	CO$_2$	133,529	1	133,529.00
	CH$_4$	1,198	21	25,158.00
	N$_2$O	0.03	310	9.3
Sub total				*158,696.30*
Industrial Processes	CO$_2$	17,254	1	17,254.00
	CH$_4$	4.21	21	88.4
	N$_2$O	0.66	310	204.6
	HFC	0.2	1,300	260
	SF$_6$	0.02	23,900	478
Sub total				*18,285.00*
Total Emissions				176,981.30
Net Total (excluding HFC and SF$_6$)				176,243.30

Constraints and Problems Encountered in Inventory

Constraints and Problems	Description	Strategy and Measures
Data Organisation	• Mismatch in sectoral detail across different published documents • Inconsistency in top-down and bottom-up data sets for same activities	• Survey done to organise the data • Assumptions was made based on most accurate published documents • Verification with related sources • Explanatory note for the inconsistency in the reporting
Non-availability of relevant data	Data for refining inventory to higher tier levels	▪Questionnaire were prepared and survey was done in respective agencies ▪Conservative approach was used to estimate the data
Non-accessibility of data	• Lack of institutional arrangements for data sharing – time consuming to compile data • Time delays in data access • Proprietary data for inventory reporting at Tier II and Tier III level	• Establish protocols and establish effective networking with data providers • Create more awareness activity • Involve industry and monitoring institutions

Constraints and Problems Encountered in Inventory

Constraints and Problems	Description	Strategy and Measures
Technical and institutional capacity needs	▪Discussions and meetings with certain organisation in identifying data needs ▪Training the specific institutions in GHG inventory methodologies and data formats	▪Series of discussions and meetings were held ▪Arrange extensive training programs
Non-representative emission factor/coefficients	Inadequate data for representative emission measurements in the sectors	Conduct measurement for key categories in future
Resources to sustain national communication effort esp. in energy sector	Sustain and enhance research networks established under Initial and second National Communications	▪Regular Updates are required to ensure sustainability of GHG Inventory (e.g. 2001 – 2005 Inventory Exercise) ▪Dedicated source of funding i.e. NRE

Further refinement in GHG Inventory

1. Continuous and improved networking with stakeholders

2. QA/QC for inventory development

3. Developing emission factors representing Malaysian conditions

4. On-line data collection to facilitate data submission

Thank You

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