

Malé Declaration 1ST emissions inventory workshop

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Part 3 – Compiling emissions by sector: The energy sources (Sectors 1-5)

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Malé Declaration on Control and Prevention of Air Pollution
and Its Likely Transboundary Effects for South Asia

Summary of emission source categories used in the manual

Energy sources:

- 1 Combustion in the Energy Industries
- 2 Combustion in Manufacturing Industries and Construction
- 3 Transport
- 4 Combustion in Other Sectors
- 5 Fugitive emissions from fuels

Other source sectors:

- 6 Industrial Processes
- 7 Solvent and Other Product Use
- 8 Agriculture
- 9 Vegetation Fires & Forestry
- 10 Waste
- 11 Natural sources

Emissions from Energy sources – *General approach*

Unless measured directly, emissions are generally estimated using emission factors:

$$\text{Emission} = (\text{emission factor}) \times (\text{activity rate})$$

For *fuel combustion activities*, the “activity rate” is the annual rate of consumption of a fuel.

For *fugitive emissions from fuels*, the “activity rate” might be:

- the annual rate of fuel production,
- the annual throughput of crude oil (for oil refineries); or
- the amount of fuel handled and distributed each year.

Emissions from Energy sources – *General approach*

Where detailed local information is not available, emissions of most pollutants can be estimated using *default* emission factors published in sources such as:

- The (US)EPA's *Compilation of Air Pollution Emission Factors* (also called "AP-42")
- The joint EMEP/Corinair *Atmospheric Emission Inventory Guidebook*;
- The *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*. (2006 version in preparation)

The exception is SO₂ for which other fuel-specific data are required in order to calculate fuel combustion emission factors.

Emissions from combustion activities – *SO₂ emission factors*

In the workbook, SO₂ emission factors for fuel combustion are calculated from:

- the % sulphur (S) content of the fuel;
- the Net Calorific Value (NCV) of fuel;
- the % S retention in ash for solid fuels (defaults given); and
- the % reduction in emissions due to emission controls (e.g. Flue Gas Desulphurization (FGD) on power stations).

For most fuels, default values for the S content are offered in the Workbook. But (unless known precisely) user must choose from:

- low S = 0.5 % medium S = 1.5 % high S = 3.0 % for *coal*
- low S = 0.3 % high S = 1.0 % for *diesel (non-road use)*
- low S = 1.0 %, medium S = 3.0 % , high S = 4.0 % for *heavy fuel oil*

Also, for *Coal, Crude oil and Natural Gas Liquids*, the compiler must take the NCVs from the International Energy Agency (IEA) database as these vary from country to country.

Emissions from combustion activities – *Fuel categories*

Coal	Gas	Oil	Combustible Renewables / wastes
Coking Coal	Gas Works Gas (GWG)	Crude Oil	Solid Biomass and Animal Products:
Other Bituminous Coal & Anthracite	Natural Gas	Natural Gas Liquids (NGL)	<i>Wood</i>
Sub-Bituminous Coal		Refinery Gas	<i>Vegetal materials and wastes</i>
Lignite		Liquefied Petroleum Gases (LPG)	<i>Other (e.g. Animal products/wastes)</i>
Patent Fuel		Motor Gasoline	Gas/Liquids from Biomass + wastes
Coke Oven Coke		Aviation Gasoline	Municipal Waste
Gas Coke		Gasoline type Jet Fuel	Industrial Waste
BKB (Brown coal briquettes)		Kerosene type Jet Fuel	Charcoal
Coke Oven Gas (COG)		Kerosene	
Blast Furnace Gas (BFG)		Gas/Diesel Oil	
		Residual Fuel Oil (RFO)	
		Other Petroleum Products	

Emissions from combustion activities

– Source sectors

Sector	Sub-sector
1. Combustion in the Energy Industries	Public Electricity and Heat
	Petroleum Refining
	Manufacture of Solid Fuels and Other Energy
2. Combustion in Manufacturing Industries and construction	Iron and Steel
	Non-ferrous metals
	Non-metallic minerals
	Chemicals
	Pulp, Paper and print
	Mining and Quarrying
	Construction
	Other (Please specify in sheet 1.1.1a, 1.1.1b or 1.1.1c)
	Autoproduction of electricity/heat
Remainder (Non-specified)	
3. Transport	Civil Aviation (Simple--not used if Detailed used)
	Civil Aviation (Detailed)
	Road transport (Simple--not used if Detailed used)
	Road transport (Detailed)
	Railways
	Navigation
	Pipeline transport
	Non-specified transport
4. Combustion in Other Sectors	Commercial/Institutional
	Residential
	Agriculture/Forestry/Fishing
	Non-specified "Other sectors"

Emissions from combustion activities – *Energy Industries*

The energy industries are sources of SO₂, NO_x, CO, NMVOC, NH₃ and PM emissions. These are:

- *Public Electricity and Heat Production*
- *Petroleum Refining.*

From the combustion of fuel for the refining of petroleum products.

- *Manufacture of Solid Fuels and Other Energy Industries.*

From the combustion of fuels during the manufacture of:

- coke
- brown coal briquettes
- patent fuel
- charcoal
- own use *

* Mainly own (on-site) energy use in coal mining and in oil and gas extraction.

Sheet: 1.1.1c Fuel consumption in kilotonnes (1000s of tonnes) per year (kt/year)

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Fuel type		Sector:	Combustion in the Energy industries						
		Sub-sector:	Public Electricity and Heat Production ¹	Petroleum Refining ²	Manufacture of Solid Fuels and Other Energy				
					Coke ovens ²	Patent fuel, BKB ²	Gas works ²	Charcoal production	Other own use ³
Coal	Coking Coal								
	Other Bituminous Coal & Anthracite								
	Sub-Bituminous Coal								
	Lignite								
	Patent Fuel								
	Coke Oven Coke								
	Gas Coke								
	BKB (Brown coal briquettes)								
	Coke Oven Gas								
	Blast Furnace Gas								
Gas	Gas Works Gas								
	Natural Gas								
Oil	Crude Oil								
	Natural Gas Liquids								
	Refinery Gas								
	Liquefied Petroleum Gases								
	Motor Gasoline								
	Aviation Gasoline								
	Gasoline type Jet Fuel								
	Kerosene type Jet Fuel								
	Kerosene								
	Gas/Diesel Oil								
	Heavy Fuel Oil								
	Petroleum coke								
	Other Petroleum Products								
Combustible renewables/ wastes	Primary Solid Biomass:								
	Wood ^c								
	Vegetal materials and wastes ^c								
	Other (e.g. animal products/wastes) ^c								
	Unspecified primary solid biomass								
	Gas/Liquids from Biomass + wastes								
	Municipal Waste								
	Industrial Waste								
Charcoal									

Sheet: 1.1.2 Default net calorific values for fuel (toe/t)

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Fuel type		Sector:	Combustion in the Energy industries					
		Sub-sector:	Public Electricity and Heat Production	Petroleum Refining	Manufacture of Solid Fuels and Other Energy			
					Coke ovens	Patent fuel, BKB	Gas works	Charcoal production
Coal ^a	Coking Coal							
	Other Bituminous Coal & Anthracite							
	Sub-Bituminous Coal							
	Lignite							
	Patent Fuel							
	Coke Oven Coke							
	Gas Coke ^e							
	BKB (Brown coal briquettes)							
	Coke Oven Gas ^b	0.6688		0.6688		0.6688		0.6688
Blast Furnace Gas ^b	0.0525		0.0525					
Gas	Gas Works Gas ^d	0.6688		0.6688		0.6688		
	Natural Gas ^f	1.2137	1.2137			1.2137		1.2137
Oil	Crude Oil ^a							
	Natural Gas Liquids ^a							
	Refinery Gas ^c	1.150	1.150					1.150
	Liquefied Petroleum Gases ^c	1.130	1.130					1.130
	Motor Gasoline ^c	1.070	1.070	1.070	1.070	1.070	1.070	1.070
	Aviation Gasoline ^c							
	Gasoline type Jet Fuel ^c							
	Kerosene type Jet Fuel ^c							
	Kerosene ^c	1.069	1.069					1.069
	Gas/Diesel Oil ^c	1.035	1.035					1.035
	Heavy Fuel Oil ^c	0.9599	0.9599					0.9599
	Petroleum coke							
	Other Petroleum Products ^c	0.9599	0.9599					0.9599
Combustible renewables/wastes	Primary Solid Biomass:							
	Wood ^c	0.3583					0.3583	0.3583
	Vegetal materials and wastes ^c	0.2866						
	Other (e.g. animal products/wastes) ^c	0.3583						
	Unspecified primary solid biomass	0.3583						
	Gas/Liquids from Biomass + wastes							
	Municipal Waste ^c	0.2627						
	Industrial Waste ^c	0.2627						
Charcoal								

Fuel type		Sector:	Combustion in the Energy industries					
		Sub-sector:	Public Electricity and Heat Production	Petroleum Refining	Manufacture of Solid Fuels and Other Energy			
					Coke ovens	Patent fuel, BKB	Gas works	Charcoal production
Coal^a	Coking Coal							
	Other Bituminous Coal & Anthracite	NCV needed		NCV needed		NCV needed		NCV needed
	Sub-Bituminous Coal	NCV needed						
	Lignite	NCV needed						
	Patent Fuel							
	Coke Oven Coke	NCV needed		OK	OK	OK		OK
	Gas Coke							
	BKB (Brown coal briquettes)							
	Coke Oven Gas	OK		OK		OK		OK
	Blast Furnace Gas	OK		OK				
Gas	Gas Works Gas	OK		OK		OK		
	Natural Gas	OK	OK			OK		OK
Oil	Crude Oil	OK	OK					OK
	Natural Gas Liquids	OK						
	Refinery Gas	OK	OK					OK
	Liquefied Petroleum Gases	OK	OK					OK
	Motor Gasoline	OK	OK	OK	OK	OK	OK	OK
	Aviation Gasoline							
	Gasoline type Jet Fuel							
	Kerosene type Jet Fuel							
	Kerosene	OK	OK					OK
	Gas/Diesel Oil	OK	OK					OK
	Heavy Fuel Oil	OK	OK					OK
	Petroleum coke	OK	OK					OK
	Other Petroleum Products	OK	OK					OK
Combustible renewables/wastes	Primary Solid Biomass:							
	Wood	OK					OK	
	Vegetal materials and wastes	OK						
	Other (e.g. animal products/wastes)	OK						
	Unspecified primary solid biomass	OK						
	Gas/Liquids from Biomass + wastes							
	Municipal Waste	OK						
	Industrial Waste	OK						
Charcoal								

NOTE: "NCV needed" indicates that a value for fuel consumption has been entered but a net calorific value (NCV) has not.

Emissions from combustion activities in the energy industries –

SO₂ emission controls

SO₂ emission controls are only significant in the "*Public Electricity and Heat Production*" sector

The % hard coal, lignite and heavy fuel oil (HFO) fuel combustion that is subject to SO₂ control must be estimated and entered into the emission control calculator provided at the bottom the relevant worksheet.

For Large Point Sources, SO₂ control efficiencies for each plant will be required if stack emissions are not measured directly.

Emissions from combustion activities in the energy industries –

SO₂ emission controls

Emission control calculator for hard coal (Other Bituminous Coal, Anthracite and subbituminous coal) combustion in public electricity

Air pollution control device (APCD)	% emission control for SO ₂	% time APCD in use (assume 50% by default)	Average % emission control achieved over a year	% hard coal fired generation capacity subject to the APCD	Average % emission control achieved in this sector
Flue Gas Desulphurization (Wet scrubber)	90	50	45		0
Flue Gas Desulphurization (Spray dry)	80	50	40		0
Flue Gas Desulphurization (Type unknown)	85	50	42.5		0
Atmospheric Fluidized Bed Combustion (AFBC) with sorbent injection	80	50	40		0
Furnace injection	38	50	19.0		0
					0.0

Emissions from combustion activities in the energy industries – *NO_x emission controls*

Technology	Representative NO _x reduction (%)
Low Excess Air (LEA)	15
Overfire Air (OFA) - Coal	25
OFA - Gas	40
OFA - Oil	30
Low NOx Burner (LNB) - Coal	45
LNB - Tangentially Fired	35
LNB - Oil	35
LNB - Gas	50
LNB with OFA - coal	50
Cyclone Combustion Modification (in power stations)	40
Flue Gas Recirculation (in industrial boilers)	40
Ammonia Injection	60
Selective Catalytic Reduction (SCR) - Coal	80
SCR - Oil	80
SCR - Gas	80
Water Injection - Gas Turbine Simple Cycle	70
SCR - Gas Turbine	80

Several types of NO_x control technologies of varying efficiency are used in power stations (and industrial boilers).

Emissions from combustion activities in the energy industries – *NO_x emission controls*

The % hard coal, lignite, heavy fuel oil (HFO) and gas combustion that is subject to NO_x control must be estimated and entered into the emission control calculator provide at the bottom the relevant worksheet.

For Large Point Sources (LPS), NO_x control efficiencies for each plant will be required if stack emissions are not measured directly.

Emissions from combustion activities in the energy industries – *NO_x emission controls*

NO_x emission control calculator for coal combustion in *public electricity*

Air pollution control device (APCD)	% emission control for NO _x ^a	% time APCD in use (assume 50% by default)	Average % emission control achieved for APCD	% coal fired generation capacity subject to the APCD	Average % emission control achieved in public electricity sector
Low Excess Air (LEA)	15	50	7.5		0
Overfire air (OFA)	25	50	12.5		
Low NO _x burner (LNB)	45	50	22.5		
LNB with OFA	50	50	25		
Reburn	55	50	27.5		
SNCR	45	50	22.5		
SCR	80	50	40		
Cyclone combustion modification	40	50	20		
LBN with SNCR	65	50	32.5		
LNB with OFA and SCR	90	50	45		

^a Mean value from AP-42 (EPA, 1995).

Emissions from combustion activities in the energy industries – *PM emission controls*

Particulate matter (PM) emissions from power stations and industry can be controlled by a variety of technologies :

Technology	Reduction range (%)
Multiple Cyclone	50 - 75
Scrubber	82 - 92
Electrostatic Precipitator (ESP)	98 - 99
Fabric Filtration (in "baghouses")	99

The % coal and heavy fuel oil (HFO) fuel consumption subject to PM control must be estimated and entered into the emission control calculator provided at the bottom the relevant worksheet.

There are no significant combustion emission controls for CO, NMVOC and NH₃

Emissions from combustion activities in the energy industries

Practical session 3:

1. Filling in workbook with dummy data (*see practical session 3 notes*)
2. Plenary session – *sharing problems encountered etc.*

Emissions from combustion activities – *Manufacturing Industry and Construction*

As for the Energy Industries, emissions are calculated from emission factors and annual rates of fuel combustion.

Generally, the major fuel-consuming activities in this sub-sector are:

- **iron and steel manufacture**
- **non-ferrous metal smelting**
- **non-metallic minerals**
- **manufacture of chemicals**
- **pulp and paper industry**
- **mining and quarrying**
- **construction**

Included, are emissions from:

- **“auto-production” of electricity and heat for use within these industries; and**
- ***off-road* mobile sources.**

Emissions from combustion activities— *Manufacturing Industry and Construction*

NO_x emission control calculator for coal combustion in *industry*

Air pollution control device (APCD)	% emission control for NO _x ^a	% time APCD in use (assume 50% by default)	Average % emission control achieved for APCD	% capacity subject to the APCD	Average % emission control achieved in industrial sector
Low Excess Air (LEA)	15	50	7.5		
Overfire air (OFA)	25	50	12.5		
Low NO _x burner (LNB)	45	50	22.5		
LNB with OFA	50	50	25		
Reburn	55	50	27.5		
SNCR	45	50	22.5		
SCR	80	50	40		
Cyclone combustion modification	40	50	20		
LBN with SNCR	65	51	33.15		
LNB with OFA and SCR	90	50	45		
^a Mean value from AP-42 (EPA, 1995).					0

PM₁₀ emission control calculator for oil combustion in *industry*

Air pollution control device (APCD)	% emission control for PM ₁₀ ^a	% time APCD in use (assume 50% by default)	Average % emission control achieved for APCD	% oil-fired generation capacity subject to the APCD	Average % emission control achieved in industrial sector
Electrostatic precipitators (ESP)	99.2	50	49.6		
Multiple cyclones	80	51	40.8		
Baghouse	99	52	51.5		
Scrubber	55	50	27.5		
^a From AP-42 (EPA, 1995).					0.0

Emissions from combustion activities– *Manufacturing Industry and Construction*

Practical session 4:

1. Filling in workbook with dummy data (*see practical session 4 notes*)
2. Plenary session – *sharing problems encountered etc.*

Emissions for Energy sources – *Transport*

The Transport sector includes emissions from both the combustion (SO_2 , NO_x , CO , NMVOC, NH_3 and PM_{10}) and evaporation (NMVOC) of fuel.

The activities included are:

- civil aviation;
- road transport;
- railway transport (freight and passenger);
- navigation (all water borne vessels except fishing boats);
- pipeline transportation; and
- non-specified transport (e.g. ground activities in airports and harbours)

Specifically excluded are:

- all *off-road* mobile activities; and
- evaporation of gasoline during refueling at service stations.

Emissions for Energy sources – *Transport*

		Sector: Transport					
		Civil Aviation ⁶	Road transport	Railways	Navigation ⁶	Pipeline transport	Non-specified transport
Sub-sector:							
Fuel type							
Coal	Coking Coal						
	Other Bituminous Coal & Anthracite						
	Sub-Bituminous Coal						
	Lignite						
	Patent Fuel						
	Coke Oven Coke						
	Gas Coke						
	BKB (Brown coal briquettes)						
	Coke Oven Gas						
	Blast Furnace Gas						
Gas	Gas Works Gas						
	Natural Gas						
Oil	Crude Oil						
	Natural Gas Liquids						
	Refinery Gas						
	Liquefied Petroleum Gases						
	Motor Gasoline						
	Aviation Gasoline						
	Gasoline type Jet Fuel						
	Kerosene type Jet Fuel						
	Kerosene						
	Gas/Diesel Oil						
	Heavy Fuel Oil						
	Petroleum coke						
	Other Petroleum Products						
	Combustible renewables/ wastes	Primary Solid Biomass:					
Wood							
Vegetal materials and wastes							
Other (e.g. animal products/wastes)							
Unspecified primary solid biomass							
Gas/Liquids from Biomass + wastes							
Municipal Waste							
Industrial Waste							
Charcoal							

Simple method

Emissions for Energy sources - *Civil Aviation (Detailed Method)*

This method is recommended for all pollutants emitted by domestic and international aircraft where relevant data are available.

Included are:

- *landing and take-off (LTO) cycle* emissions; and
- *cruise activity* emissions (domestic only)

If detailed activity data are available, separate emission factors for each type of aircraft should be used.

Otherwise, default EFs are also given in the Workbook typical of “old fleet” or “average fleet” aircraft.

Emissions for Energy sources - Civil Aviation (Detailed Method)

Domestic flights: aircraft type (* =old fleet)	A	B		C	D	E	F
	Total number of LTOs per aircraft type per year	Fuel consumption per LTO (kg/LTO)		Fuel consumption for LTO activities (Tonnes)	Total fuel sold for domestic aviation (TJ)	Total fuel sold for domestic aviation (Tonnes)	Fuel consumed for cruise activities (Tonnes)
			Default ^b	$C = A \times B/1000$	(From Sheet 1.1.1)	$E = 1000 \times D / (\text{Net Calorific Value}^f)$	$F = (E \times (A/A_{\text{Total}})) / C$
Airbus A310			1540.5	0			0.00
Airbus A320			802.3	0			0.00
Airbus A330			2231.5	0			0.00
Airbus A340			2019.9	0			0.00
BAe 111			681.6	0			0.00
BAe 146			569.5	0			0.00
Boeing 727*			1412.8	0			0.00
Boeing 737-100			919.7	0			0.00
Boeing 737-400			825.4	0			0.00
Boeing 747 100-300			3413.9	0			0.00
Boeing 747-400			3402.2	0			0.00
Boeing 757			1253	0			0.00
Boeing 767 300 ER			1617.1	0			0.00
Boeing 777			2562.8	0			0.00
McDonnell Douglas DC-8*			1839.4	0			0.00
McDonnell Douglas DC-9*			876.1	0			0.00
McDonnell Douglas DC-10			2381.2	0			0.00
McDonnell Douglas M81-88			1003.1	0			0.00
Fokker 28			666.1	0			0.00
Fokker 100			744.4	0			0.00
Type unknown (old fleet) ^h			920	0			0.00
Type unknown (average fleet) ^g			825	0			0.00
Other (Please specify)				0			0.00
Total	0			0	0	0	0

Emissions for Energy sources - Civil Aviation (Detailed Method)

Domestic flights: aircraft type (* =old fleet)	A	G		H		I	J		K		L
	Total number of LTOs per aircraft type per year	SO2 emission factor per LTO (kg/LTO)		SO ₂ emission factor for cruise activities (kg/Tonne)		SO ₂ emissions (Tonnes)	NOx emission factor per LTO (kg/LTO)		NOx emission factor for cruise activities (kg/Tonne)		NOx emissions (Tonnes)
			Default ^c		Default ^c	$I = (A \times G/1000) + (F \times H/1000)$		Default ^b		Default ^b	$L = (A \times J/1000) + (F \times K/1000)$
Airbus A310			1.5		1	0.00		23.2		10.3	0.00
Airbus A320			0.8		1	0.00		10.8		10.3	0.00
Airbus A330			2.2		1	0.00		36.1		10.3	0.00
Airbus A340			2		1	0.00		35.4		10.3	0.00
BAe 111			0.7		1	0.00		4.9		10.3	0.00
BAe 146			0.6		1	0.00		4.2		10.3	0.00
Boeing 727*			1.4		1	0.00		12.6		9.4	0.00
Boeing 737-100			0.9		1	0.00		8		10.3	0.00
Boeing 737-400			0.8		1	0.00		8.3		10.3	0.00
Boeing 747 100-300			3.4		1	0.00		55.9		10.3	0.00
Boeing 747-400			3.4		1	0.00		56.6		10.3	0.00
Boeing 757			1.3		1	0.00		19.7		10.3	0.00
Boeing 767 300 ER			1.6		1	0.00		26		10.3	0.00
Boeing 777			2.6		1	0.00		53.6		10.3	0.00
McDonnell Douglas DC-8*			1.8		1	0.00		14.8		9.4	0.00
McDonnell Douglas DC-9*			0.9		1	0.00		7.3		9.4	0.00
McDonnell Douglas DC-10			2.4		1	0.00		41.7		10.3	0.00
McDonnell Douglas M81-88			1		1	0.00		12.3		10.3	0.00
Fokker 28			0.7		1	0.00		5.2		10.3	0.00
Fokker 100			0.7		1	0.00		5.8		10.3	0.00
Type unknown (old fleet ^h)			1		1	0.00		8		10.3	0.00
Type unknown (average fleet ^g)			0.85		1	0.00		8.3		10.3	0.00
Other (Please specify)					1	0.00				10.3	0.00
Total	0					0					0.00

Road transport emissions – detailed or simple method?

- Emission Factors usually depend on vehicle type, age, fuel type, emission controls and so forth.
- If only national total fuel consumption data available - *simple method* using average ‘bulk’ emission factors allows a very rough estimate.
- If data are available on vehicle fleet composition (number of vehicles by class and age) and average distance travelled per year – then the *detailed method* is recommended.
- Workbook will permit either method.

Mobile emissions of (detailed) for on-road vehicles

Sheet 1.9.3 Mobile emissions (detailed) of NO_x, CO and PM for on-road vehicles.

Sector: Transport (Detailed method)

Sub-sector: Road transportation

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			A	B	C	D
			Number of vehicles in use	Average distance travelled per vehicle (km/yr)	Total distance travelled (km/yr)	Distance travelled on unpaved roads as a percent of total (%)
Fuel	Vehicle class	Year of manufacture			C = A x B	
Gasoline	2-wheeler, 2-stroke	Pre 1986			0	
		1986-1990			0	
		1991-1995			0	
		1996-2000			0	
		2001-2005			0	
		2006-2010			0	
		2011-2015			0	
Gasoline	2-wheeler, 4-stroke	Pre 1986			0	
		1986-1990			0	
		1991-1995			0	
		1996-2000			0	
		2001-2005			0	
		2006-2010			0	
		2011-2015			0	
Gasoline	3-wheeler, 2-stroke	Pre 1986			0	

Mobile emissions of NO_x (detailed) for on-road vehicles

Fuel	Vehicle class	Year of manufacture	E		F	G
			NO _x emission factor (g/km)		NO _x deterioration factor	NO _x emissions (Tonnes)
				Default ^b		G = C x F x E/1000000
Gasoline	2-wheeler, 2-stroke	Pre 1986		0.03	1.4	0
		1986-1990		0.03	1.4	0
		1991-1995		0.03	1.3	0
		1996-2000		0.06	1.2	0
		2001-2005		0.07	Newer than year 2000!	#VALUE!
		2006-2010		0.08	Newer than year 2000!	#VALUE!
Gasoline	2-wheeler, 4-stroke	Pre 1986		0.31	1.4	0
		1986-1990		0.31	1.4	0
		1991-1995		0.31	1.3	0
		1996-2000		0.3	1.2	0
		2001-2005		0.3	Newer than year 2000!	#VALUE!
		2006-2010		0.3	Newer than year 2000!	#VALUE!
Gasoline	3-wheeler, 2-stroke	Pre 1986		0.05	1.7	0

Mobile emissions of particulate matter (PM₁₀) (detailed) for on-road vehicles

Fuel	Vehicle class	Year of manufacture	D Distance travelled on unpaved roads as a percent of total (%)	P		Q	T		U	V
				Paved road dust (PM ₁₀) emission factor (g/km)		Paved road dust (PM ₁₀) emissions (Tonnes)	Unpaved road dust (PM ₁₀) emission factor in dry weather (g/km)		Percent dry days (< 0.25 mm precipitation) in a year (%)	Unpaved road dust (PM ₁₀) emissions (Tonnes)
					Default ⁱ	$Q = C \times (100 - D) / 100 \times P / 1000000$		Default ^k		$V = U / 100 \times C \times (D / 100) \times T / 1000000$
Gasoline	2-wheeler, 2-stroke	Pre 1986			0.02	0		169		0
		1986-1990			0.02	0		169		0
		1991-1995			0.02	0		169		0
		1996-2000			0.02	0		169		0
		2001-2005			0.02	0		169		0
		2006-2010			0.02	0		169		0
		2011-2015				0				0
Gasoline	2-wheeler, 4-stroke	Pre 1986			0.02	0		169		0
		1986-1990			0.02	0		169		0
		1991-1995			0.02	0		169		0
		1996-2000			0.02	0		169		0
		2001-2005			0.02	0		169		0
		2006-2010			0.02	0		169		0
		2011-2015				0				0
Gasoline	3-wheeler, 2-stroke	Pre 1986			0.04	0		396		0

Emissions for Energy sources – “Other sectors”

This category includes emissions of SO₂, NO_x, CO, NMVOC, NH₃ and PM from fuel combustion in:

- “*Commercial and Institutional*” buildings
- residential “*Households*”; and
- “*Agriculture, Forestry and Fishing*”.

It includes mobile emissions from off-road activities in agriculture and forestry and from fishing vessels engaged in domestic inland, coastal or deep-sea fishing.

Emissions for Energy sources – ‘Other sectors’

Sheet: 1.1.1b Fuel consumption in thousands of tonnes oil equivalent per year (ktoe/year)

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		Sector: Combustion in Other Sectors		
		Sub-sector:		
Fuel type		Commercial/ Institutional	Residential	Agriculture/ Forestry/Fishing
Coal	Coking Coal			
	Other Bituminous Coal & Anthracite			
	Sub-Bituminous Coal			
	Lignite			
	Patent Fuel			
	Coke Oven Coke			
	Gas Coke			
	BKB (Brown coal briquettes)			
	Coke Oven Gas			
	Blast Furnace Gas			
Gas	Gas Works Gas			
	Natural Gas			
Oil	Crude Oil			
	Natural Gas Liquids			
	Refinery Gas			
	Liquefied Petroleum Gases			
	Motor Gasoline			
	Aviation Gasoline			
	Gasoline type Jet Fuel			
	Kerosene type Jet Fuel			
	Kerosene			
	Gas/Diesel Oil			
	Heavy Fuel Oil			
	Petroleum coke			
	Other Petroleum Products			
Combustible renewables/ wastes	Primary Solid Biomass:			
	Wood			
	Vegetal materials and wastes			
	Other (e.g. animal products/wastes)			
	Unspecified primary solid biomass			
	Gas/Liquids from Biomass + wastes			
	Municipal Waste			
	Industrial Waste			
Charcoal				

Emissions for Energy sources – *Fugitive emissions from fuels*

This sub-sector covers all *non-combustion* activities related to fossil fuel:

- extraction (oil well drilling, oil/gas production, venting and flaring);
- processing (coke production, oil refining);
- storage (natural gas, crude oil and petroleum products); and
- distribution and handling (loading crude onto tankers, pipeline transport of oil/gas, gasoline emissions from service stations);

Emissions for Energy sources – *Fugitive emissions from fuels*

The use of oil and gas to provide energy for internal (own) use in fuel extraction and processing are not considered to be fugitive emissions.

Also excluded are evaporative emissions from vehicles as these are included under ‘Transport’.

This category forms a major component of national NMVOC emissions in many countries.

Not all fugitive emissions from fuels are NMVOCs. For example, PM₁₀ arise from coke production and NO_x and CO are emitted during oil refining and gas flaring.

Compilation of emissions for Energy sources - *Transport (simple method) and combustion in other sectors*

Practical session 5a:

1. Filling in workbook with dummy data (*see practical session 5a notes*)
2. Plenary session – *sharing problems encountered etc.*

Compilation of emissions for Energy sources - *Transport (detailed method)*

Practical session 5b:

1. Filling in workbook with dummy data (*see practical session 5b notes*)
2. Plenary session – *sharing problems encountered etc.*

Compilation of emissions for Energy sources - *Fugitive emissions from fuels*

Practical session 5c:

1. Filling in workbook with dummy data (*see practical session 5c notes*)
2. Plenary session – *sharing problems encountered etc.*