GHG calculations

Lecture 6

GHG calculations

- Fuel consumption inventory
- Emission factors of each greenhouse gases
- Emission factors with respect to CO2 equivalent
- Examples

Sources: AR4,

http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html

http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_3_Ch3_Mobile_Combustion.pdf

Definitions

- A greenhouse gas is defined as any of the atmospheric gases that contribute to the greenhouse effect by absorbing infrared radiation produced by solar warming of the Earth's surface. They include CO2, CH4, N2O and water vapour.
- An emission factor is defined as the average emission rate of a given GHG for a given source, relative to units of activity.

Or

Emission factor is a measure of the average amount of a specific pollutant or material discharged into the atmosphere by a specific process, fuel, equipment, or source. It is expressed as number of pounds (or kilograms) of particulate per ton (or metric ton) of the material of fuel.

- Activity data, according to 1996 IPCC Guidelines for National Greenhouse Gas Inventories, are defined as data on the magnitude of human activity resulting in emissions or removals taking place during a given period of time.
- Global warming potentials (GWP) is a ratio denoting the effect of a quantity of a greenhouse gas on climate change compared with an equal quantity of carbon dioxide. It is used for presentation for CH4 and N2O in terms of CO2 equivalent are 25 and 296, respectively.

Energy Consumption in 1995/96
Unit in 000 GJ

Category	Fueltype	Sector						
		Residential	Industrial	Commercial	Transport	Agricultural	Other	Grand Total
Traditional	Agr residue	10349.0	205.0	17.0	0.0	0.0	0.0	10571.0
	Animal dung	17568.0	0.0	0.0	0.0	0.0	0.0	17568.0
	Fuelwood	231109.0	3430.0	956.0	0.0	0.0	0.0	235495.0
Traditional Total		259026.0	3635.0	973.0	0.0	0.0	0.0	263634.0
Commercial	ATF	0.0	0.0	0.0	1469.2	0.0	0.0	1469.2
	Coal	15.0	2600.8	366.1	103.0	0.0	0.0	3085.0
	Electricity	1183.4	1291.2	226.5	5.2	90.3	262.2	3058.9
	Fueloil	0.0	308.2	32.6	0.0	0.0	0.0	340.9
	Gasoline	0.0	14.2	0.0	1365.3	0.0	0.0	1379.6
	HSDiesel	0.0	3294.7	0.0	5650.6	556.2	0.0	9501.5
	Kerosene	6087.0	384.3	1096.7	0.0	0.0	0.0	7568.0
	LDiesel	0.0	2.7	0.0	127.7	43.9	0.0	174.2
	LPG	796.0	0.0	119.9	0.0	0.0	0.0	915.9
	Other Petroleum	0.0	240.2	25.4	0.0	0.0	0.0	265.6
Commercial Total		8081.4	8136.3	1867.3	8720.9	690.4	262.2	27758.5
Renewable	Biogas	411.9	0.0	0.0	0.0	0.0	0.0	411.9
	Microhydro	23.0	0.0	0.0	0.0	0.0	0.0	23.0
	Solar	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Renewable Total		434.8	0.0	0.0	0.0	0.0	0.0	434.8
Grand Total		267542.3	11771.3	2840.3	8720.9	690.4	262.2	291827.4

Energy sector synopsis report 2010, WECS, Nepal [www.wecs.gov.np]

Carbon Emission Factor

Fossil fuel		CO_2 emission factor (kg/TJ)	Net calorific value (TJ/Gg) Gg=1000t	CO_2 emission factor (t-CO_2/t (Fuel))
Liquid Fossil	Crude Oil	73,300	42.3	3.101
	Motor Gasoline	69,300	44.3	3.070
	Other Kerosene	71,900	43.8	3.149
	Gas/Diesel Oil	74,100	43.0	3.186
	Liquefied Petroleum Gases	63,100	47.3	2.985
Solid Fossil	Anthracite	98,300	26.7	2.625
	Sub-Bituminous Coal	96,100	18.9	1.816
	Lignite	101,000	11.9	1.202
Gaseous Fossil	Natural Gas	56,100	48.0	2.693

2006 IPCC Guidelines for National Greenhouse Gas Inventories, p. 1.18-1.24, Intergovernmental Panel on Climate Change, 2006.
[Default carbon oxidation factor is 1] [CO_2 emission factors t-CO_2/t (Fuel) are calculated for this document and do not appear in the IPCC guideline]

TABLE 3.2.1
ROAD TRANSPORT DEFAULT CO_2 EMISSION FACTORS AND UNCERTAINTY RANGES [a]

Fuel Type	Default (kg/TJ)	Lower	Upper
Motor Gasoline	69 300	67 500	73 000
Gas/ Diesel Oil	74 100	72 600	74 800
Liquefied Petroleum Gases	63 100	61 600	65 600
Kerosene	71 900	70 800	73 700
Lubricants [b]	73 300	71 900	75 200
Compressed Natural Gas	56 100	54 300	58 300
Liquefied Natural Gas	56 100	54 300	58 300

Source: Table 1.4 in the Introduction chapter of the Energy Volume.
Notes:
[a] Values represent 100 percent oxidation of fuel carbon content.
[b] See Box 3.2.4 Lubricants in Mobile Combustion for guidance for uses of lubricants.

Source:
http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_3_Ch3_Mobile_Combustion.pdf

TABLE 3.2.2
ROAD TRANSPORT N_2O AND CH_4 DEFAULT EMISSION FACTORS AND UNCERTAINTY RANGES [a]

Fuel Type/Representative Vehicle Category	CH_4 (kg /TJ)			N_2O (kg /TJ)		
	Default	Lower	Upper	Default	Lower	Upper
Motor Gasoline -Uncontrolled [b]	33	9.6	110	3.2	0.96	11
Motor Gasoline –Oxidation Catalyst [c]	25	7.5	86	8.0	2.6	24
Motor Gasoline –Low Mileage Light Duty Vehicle Vintage 1995 or Later [d]	3.8	1.1	13	5.7	1.9	17
Gas / Diesel Oil [e]	3.9	1.6	9.5	3.9	1.3	12
Natural Gas [f]	92	50	1 540	3	1	77
Liquified petroleum gas [g]	62	na	na	0.2	na	na
Ethanol, trucks, US [h]	260	77	880	41	13	123
Ethanol, cars, Brazil [i]	18	13	84	na	na	na

Source:
http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_3_Ch3_Mobile_Combustion.pdf

GHG Calculations

Activity data X Emission Factors = GHG Emissions

- Activity data: fuel consumption data
- Emission factor: A unique value for scaling emissions to activity data in terms of a standard rate of emissions per unit of activity (e.g., grams of carbon dioxide emitted per barrel of fossil fuel consumed, kg CO2/kg fuel).
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Transport fuel consumption in 2011-12

Fuel	Activity data, TJ	Emission factor, kg/TJ	CO2 , tons
Gasoline	6,831.42	69,300	473,417.11
Diesel	11,997.49	74,100	889,014.05
LPG	2,090.76	63,100	131,927.07
Total	20,919.67	-	2,494,358.23

GHG Calculations

GHG Emissions = Activity data X Emission Factors X Global Warming Potential

Examples

CO2 emissions from transport fuel in 2011/12

S.N	Fuel	Activity data, KL	Energy density, MJ/L [MJ/kg*]	Activity data, TJ	Emission factor, kg/TJ	CO2, tons	Remarks
1	Motor spirit	199,749.00	34.20	6,831.42	69,300.00	473,417.11	
2	Diesel	324,256.50	37.00	11,997.49	74,100.00	889,014.05	
3	LPG*, MT	45,352.75	46.10	2,090.76	63,100.00	131,927.07	
	Total			**20,919.67**		**1,494,358.23**	
	GWP	1	25	298			
S.N	**EF, kg/TJ**	**CO2**	**CH4**	**N2O**	**CO2e**	**Activity data**	**CO2e, tons**
1	Petrol	69,300.00	25	8	72,309.00	6,831.42	493,972.85
2	Diesel	74,100.00	3.9	3.9	75,359.70	11,997.49	904,127.28
3	LPG	63,100.00	62	0.8	64,888.40	2,090.76	135,666.19
							1,533,766.32

Examples

Calculate total CO2e for the following fuel consumed in Nepal for given year (collect activity data from NOC website):

a) Motor spirit
b) Diesel
c) Kerosene
d) LPG
e) ATF

Note: Roll no. 1 (2071-72), 2 (2070-71), 3 (2069-70) so on…..