SNAP toolkit for Short-Lived Climate Pollutants (SLCPs) - Data requirements for LEAP-IBC from participating countries

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In order for the participating pilot countries to be able to use the LEAP-IBC tool, certain data inputs are required for the emissions scenario modelling to be performed. In the interests of efficiency, it would be helpful if the pilot study countries could **start now to acquire the local information and data required as input to the toolkit.**

The CCAC SNAP project will concentrate on the effect of implementing the SLCP measures, and so ensuring that the SLCP-related data are as comprehensive and up-to-date as possible is a priority in the current phase of the SNAP project – **the data required for this are shown in Part 1 of this note**.

However, in order to look at the full impact of emission scenarios – we would also like to improve the overall inventory of GHG and air pollutant emissions for each country. SEI will provide initial data from international sources where these are available and add them to the LEAP-IBC template for each SNAP country, but if time allows and there is interest, data from national sources would also be great to upgrade - the additional data needed to carry this out are explained in Part 2 of this note. (Note – this is optional at this stage, the priority is to collect the data described in Part 1).

Part 1 - high priority data requirements relevant to the SLCP measures:

1. **Brick kilns:** What was the fuel use by fuel type (e.g. kilotonnes coal burnt per year) and technology (traditional, VSBK, Hoffman kiln, Zig-zag kiln etc.) for 2010? Also production rate of bricks, by technology/fuel type.

2. **Coke production technology split:** What proportion of total production is from 'traditional' coke ovens versus 'modern recovery' ovens?

3. **Oil production data:** (i) Number of wells drilled per year? (ii) How much crude oil is loaded onto (a) marine vessels or (b) rail tank cars/tank trucks (kt/yr)? (iii) How much is transported in pipelines (kt/yr)? (iv) How much is transported in marine tankers (kt/yr)? (v) How much oil production is onshore and how much is offshore. (vi) Annual volume of gas flared (1000s cubic metres (m^3))

4. **Methane from coal mining**: What is the coal production split between surface and deep coal mines? Was any methane recovered in 2010 - if so, how much (t/yr)?

5. **Road transport**: By fuel type and vehicle category, what were (A) the number of vehicles; (B) the annual average distance travelled (km/yr) and (C) the % distance travelled on unpaved roads (see Annex 1 for detailed list of vehicle categories by Euro standard).

6. **Residential (domestic) biomass fuel consumption:** (i) What are the main types of residential biomass stoves used, and (ii) What are the annual amounts (kt) of wood, crop residues, animal dung, charcoal etc. burnt as fuel in each type?

7. **Crop residue open-burning:** For each type of crop grown, what percentage of the crop waste residues are typically burnt in the field? The crop types are: Rice, Wheat, Millet, Soya, Maize, Potatoes, Jute, Cotton (Seed cotton), Groundnut, Sugarcane, Rapeseed and mustard, Others (please specify). (A default of 25% of waste crop residue burned in the field will be assumed if no data are provided. Default crop production data will be taken from FAOSTAT unless local production data are also supplied.)

8. **Rice cultivation (methane emissions)**: (a) For total rice cultivation in 2010, what was the % shares of '*rain-fed and deepwater*'[1], '*irrigated*'[2] and '*upland*'[3] (hill) rice paddy. For the irrigated rice paddy, what proportion was '*intermittent aeration*'[4] rather than '*continuously flooded*'[5]? (b) Also, what was average rate (tonnes/ha) and type of organic amendment (straw[6], compost, farmyard manure or green manure) applied to '*rainfed and deepwater'* and '*irrigated*' rice cultivation?

9. **Solid waste incineration by 'open burning'**: In 2010, how much municipal solid waste (MSW) (kt/yr) was disposed of by open-burning (e.g. in back-yards, streets or waste dumps)?

10. **Municipal solid waste (MSW) in landfill (methane emissions):** What was the amount (kt/yr) of methane (CH_4) recovered from landfill in 2010? (Also, if known, what was the population whose waste was collected, the per capita MSW generation rate and the fraction of MSW sent to solid waste disposal sites? Defaults can be used in the model if this information is lacking.)

11. **Domestic wastewater treatment and discharge (methane emissions):** (a) What is the population income group split (either as % or proportion) between *Rural*, *Urban high income* and *Urban low income* for 2010)? (b) Also, for each income group, what was the share represented by each treatment system (see Table 2)?

[1] *Rainfed and deep water*: Fields are flooded for a significant period of time and water regime depends solely on precipitation

[2] *Irrigated*: Fields are flooded for a significant period of time and water regime is fully controlled.

[3] *Upland*: Fields are never flooded for a significant period of time.

[4] *Intermittently aerated*: Fields have at least one aeration period of more than 3 days during the cropping season

[5] *Continuously flooded*: Fields have standing water throughout the rice growing season and may only dry out for harvest (end-season drainage).

[6] *'Straw application'* means that straw is incorporated into the soil, it does not include straw just placed on the soil surface or straw burnt on the field.

Table 2 The wastewater treatment split by population income group required for methane emissions estimation in the emissions module of the toolkit.

Income group	**Fraction of population in income group** [1] (fraction 0-1.0; total for all 3 income groups must = 1.0)	**Type of treatment system**	**Utilization of treatment split within income group** (fraction 0-1.0; total within income group must equal 1.0)
Rural		Latrine	
		Septic tank	
		Anaerobic reactor or deep lagoon	
		Aerobic treatment plant	
		Untreated (Sea, river or lake discharge)	
Urban high income		Latrine	
		Septic tank	
		Anaerobic reactor or deep lagoon	
		Aerobic treatment plant	
		Untreated (Sea, river or lake discharge)	
Urban low income		Latrine	
		Septic tank	
		Anaerobic reactor or deep lagoon	
		Aerobic treatment plant	
		Untreated (Sea, river or lake discharge)	

Part 2 (optional – lower priority) Data requirements for compiling a more accurate, complete national emission inventory.

In most cases, the default **emission factors**[7] contained in the model will be adequate (although they could be replaced by national emission factors if available). However, for some pollutants such as SO_2, the sulphur (S) content of the fuel determines the emission factor and so national information on this aspect of fuel quality is required for more accurate emissions estimates. Often, the default EFs given in the toolkit are 'uncontrolled' and so, for certain sectors, information on the types and 'penetration rates' of emission control technologies in that country will be needed. For example, power stations may be fitted with flue-gas desulphurization (FGD) devices to control S emissions or low-NOx burners to reduce NOx emissions.

In addition to emission factors, data on the relevant **activity rates**[8] are needed to be able to calculate more accurate emissions. Where data from international sources are available (e.g. the International Energy Agency (IEA) Statistics, or agricultural data from FAOSTAT), these will already be included in the model (although they could be replaced by local data if preferred).

[7] An **emission factor** (EF) is the rate of emission of a pollutant per unit of activity e.g. in a power station - kg NO_X per tonne coal burnt

[8] The **activity rate** is some measure of the annual level of the relevant activity e.g. in power stations - kilotonnes (kt) coal burnt per year

1. **What are the sulphur contents (%S) of fuel used in the country?** (i) **Coal** by type (e.g. bituminous coal, lignite) and, if it varies, by sector (e.g. electricity power stations, industry etc.): typical range 0.5% – 3%. (ii) **Gas/diesel oil**: typical range 0.3% – 1%. (iii) **Heavy fuel oil** (HFO) also known as Residual fuel oil (RFO): typical range 1 – 4%. (iv) **Motor gasoline**: (IPCC default of 0.1% will used if no information provided)

2. **Electricity Power Stations (SO_2 emissions):** Do any power stations have sulphur dioxide (SO_2) emission controls? If yes, for each type of fuel (hard coal, lignite or heavy fuel oil (HFO), the % fuel use subject to each type of control (e.g. flue-gas desulphurization (FGD), Atmospheric Fluidized Bed Combustion (AFBC), Furnace injection) will be required for 2010. (By default, zero SO_2 emission control will be assumed.)

3. **Solid fuel use in cement production:** What was the consumption of hard coal, lignite or petroleum coke (kt/yr) used for cement production in 2010? (This is needed to account for the ~80% of sulphur in the solid fuel that gets absorbed into the cement.)

4. **Emission controls for NOx in Electricity Power Generation and in Industry:** For a each fuel type (hard coal, lignite, natural gas, crude oil, gas/diesel oil or HFO), what was the % fuel use in that sector (i.e. Power or Industry) that was subject to each type of control (see Table 3 for list of technologies) in 2010? (By default, zero NOx emission control will be assumed.)

Table 3 Representative NOx emission control reductions for power stations and industrial boilers.

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

5. **Chemicals production**: What was annual production (tonnes /yr) in 2010 of: Nitric acid, Sulphuric acid, Adipic acid, Carbon black and Titanium dioxide?

6. **Cement production and Lime production**: What were the types of particulate matter (dust) controls typically used - if any (e.g. electrostatic precipitator, fabric filter) in 2010?

7. **Metals production – sulphur recovery**: What were the average levels of sulphur removal (% S recovered) during the smelting of (i) copper, (ii) lead (primary), (iii) lead (secondary) and (iv) zinc in 2010?

8. **Solvent and other product use (NMVOC emissions)**. What were the levels of consumption (or chemical products manufacture) in 2010 of the NMVOC emitting substances/processes listed in Table 4. Also what were the average levels of solvent recovery (if any) for metal degreasing and dry cleaning of fabrics?

Table 4 Activity data requirements for solvent and other product use

Process	Units for activity rate
Paint application (solvent based)	
Industrial	tonnes paint sold
Decorative	tonnes paint sold
Unknown	tonnes paint sold
Paint application (water based)	tonnes paint sold
Metal degreasing	tonnes solvent consumed
Dry cleaning of fabrics	tonnes solvent consumed
Chemical products manufacture:	
Polyester processing	tonnes of monomer
Polyvinylchloride	tonnes product
Polyurethane	tonnes foam processed
Polystyrene foam	tonnes product
Rubber processing	tonnes product
Paints, varnish, inks and glues	tonnes product
Other use of solvents:	
Mineral wool enduction	tonnes product
Glass wool enduction	tonnes product
Printing industry	
Heat set offset	tonnes ink consumed
Publication gravure	tonnes ink consumed
Packaging (small flexography)	tonnes ink consumed
Fat, edible and non-edible oil (solvent ext	tonnes seed
Application of glue and adhesives	tonnes product used

Annex 1

Mobile emissions from on-road vehicles (Detailed method).

Fuel	Vehicle class (For definition of EMEP/EEA vehicled classes see Table 2.1 at bottom of this worksheet)	NO_x emission factor (g/km) Default*	CO emission factor (g/km) Default*	NMVOC emission factor (g/km) Default*	NH_3 emission factor (g/km) Default*	PM_{10} emission factor (g/km) Default*	$PM_{2.5}$ emission factor (g/km) = PM10 emission factors) Default* [l]	Unpaved road dust (PM_{10}) emission factor in dry weather (g/km) Default [m]	Unpaved road ($PM_{2.5}$) emissions factor (g/km) Default [n]	BC emission factor (% of $PM_{2.5}$) Default [o]	OC emission factor (OC/BC ratio) Default [o]
Gasoline	Passenger cars (Uncontrolled) [a]	2.09[a]	18.9[a]	2.41[a]	0.10[a]	0.0029[a]	0.0029[a]	126	19	2	37.7
Gasoline	Passenger cars (Moderate control) [d]	1.29	6.49	0.29	0.002	0.0022	0.0022	126	19	30	1.79
Gasoline	Passenger cars (Euro I) [e]	0.53	3.92	0.53	0.0922	0.0022	0.0022	126	19	25	1.92
Gasoline	Passenger cars (Euro 2) [e]	0.255	2.04	0.251	0.1043	0.0022	0.0022	126	19	25	1.92
Gasoline	Passenger cars (Euro 3) [e]	0.119	1.82	0.119	0.0342	0.0011	0.0011	126	19	15	2.31
Gasoline	Passenger cars (Euro 4) [e]	0.065	0.62	0.065	0.0342	0.0011	0.0011	126	19	15	2.31
Gasoline	Passenger cars (Euro 5) [e]	0.065	0.62	0.065	0.0123	0.0014	0.0014	126	19	15	2.31
Gasoline	Passenger cars (Euro 6) [e]	0.065	0.62	0.065	0.0123	0.0014	0.0014	126	19	15	2.31
Gasoline	Light-commercial vehicles (Conventional) [i]	3.09	25.5	3.44	0.0025	0.0023	0.0023	225	34	30	1.79
Gasoline	Light-commercial vehicles (Euro 1) i	0.563	8.82	0.614	0.0758	0.0023	0.0023	225	34	25	1.92
Gasoline	Light-commercial vehicles (Euro 2) i	0.23	5.89	0.304	0.091	0.0023	0.0023	225	34	25	1.92
Gasoline	Light-commercial vehicles (Euro 3) i	0.129	5.05	0.189	0.0302	0.0011	0.0011	225	34	15	2.31
Gasoline	Light-commercial vehicles (Euro 4) i	0.064	2.01	0.128	0.0302	0.0011	0.0011	225	34	15	2.31
Gasoline	Light-commercial vehicles (Euro 5) i	0.064	1.30	0.096	0.0123	0.0014	0.0014	225	34	15	2.31
Gasoline	Light-commercial vehicles (Euro 6) i	0.064	1.30	0.096	0.0123	0.0012	0.0012	225	34	15	2.31
Gasoline	Heavy duty (Conventional) [c]	6.6	59.5	5.25	0.0019	0.0023	0.0023	450	68	30 [H]	1.79 [H]
Gasoline	Motorcycles (2-stroke) (Uncontrolled)[a]	0.375[a]	23.2[a]	12.8[a]	0.0023[a]	0.21[a]	0.21[a]	36	5	10	6.90
Gasoline	Motorcycles (2-stroke) (Moderate control) [f]	0.067	24.3	9.97	0.0019	0.16	0.16	36	5	10	6.90
Gasoline	Motorcycles (2-stroke) (Mot-Euro 1)	0.028	16.3	5.82	0.0019	0.064	0.064	36	5	20	3.08
Gasoline	Motorcycles (2-stroke) (Mot-Euro 2)	0.104	11.2	1.84	0.0019	0.032	0.032	36	5	20	3.08
Gasoline	Motorcycles (2-stroke) (Mot-Euro 3)	0.280	2.73	0.806	0.0019	0.0096	0.0096	36	5	20	3.08
Gasoline	Motorcycles (4-stroke) (Uncontrolled)[a]	0.375[a]	23.2[a]	12.8[a]	0.0023[a]	0.21[a]	0.21[a]	36	5	15	4.30
Gasoline	Motorcycles (4-stroke) (Moderate control) [g]	0.233	25.7	1.68	0.0019	0.014	0.014	36	5	15	4.30
Gasoline	Motorcycles (4-stroke) (Mot-Euro 1)	0.477	13.8	1.19	0.0019	0.014	0.014	36	5	25	2.31
Gasoline	Motorcycles (4-stroke) (Mot-Euro 2)	0.317	7.17	0.918	0.0019	0.0035	0.0035	36	5	25	2.31
Gasoline	Motorcycles (4-stroke) (Mot-Euro 3)	0.194	3.03	0.541	0.0019	0.0035	0.0035	36	5	25	1.92
Gasoline	3-Wheelers (2-stroke) (uncontrolled)	0.375[b]	23.2[b]	12.8[b]	0.0023[b]	0.21[b]	0.21[b]	90	14	10	6.90
Gasoline	3-Wheelers (2-stroke) (Medium control)	0.30 [A]	3.15 [A]	6.04 [A]	0.0023[a]	0.11[A]	0.11[A]	90	14	10	6.90
Gasoline	3-Wheelers (2-stroke) (Bharat 1 = Euro 1)	0.20 [B]	1.37 [B]	2.53 [B]	0.0023[a]	0.045 [B]	0.045 [B]	90	14	20	3.08
Gasoline	3-Wheelers (2-stroke) (Bharat 2 = Euro 2)	0.16 [C]	1.15 [C]	1.63 [C]	0.0023[a]	0.043 [C]	0.043 [C]	90	14	20	3.08
Gasoline	3-Wheelers (4-stroke) (Bharat 1 = Euro 1)	0.61 [B]	4.47 [B]	1.57 [B]	0.0023[a]	0.011[B]	0.011[B]	90	14	25	2.31
Gasoline	3-Wheelers (4-stroke) (Bharat 2 = Euro 2)	0.53 [C]	2.29 [C]	0.77 [C]	0.0023[a]	0.015 [C]	0.015 [C]	90	14	25	2.31
Gasoline	**Total for gasoline**										
Diesel	3-Wheelers (Moderate control)	0.93 [A]	9.16 [A]	0.63 [A]	0.001	0.782 [A]	0.782 [A]	90	14	55	0.54
Diesel	3-Wheelers (Bharat 1 = Euro 1)	0.69 [B]	2.09 [B]	0.16 [B]	0.001	0.347 [B]	0.347 [B]	90	14	70	0.31
Diesel	3-Wheelers (Bharat 2 = Euro 2)	0.51 [C]	0.41 [C]	0.14 [C]	0.001	0.091 [C]	0.091 [C]	90	14	80	0.18
Diesel	Passenger cars (Conventional) [h]	0.546	0.688	0.159	0.001	0.2209	0.2209	126	19	55	0.54
Diesel	Passenger cars (Euro 1) [h]	0.690	0.414	0.047	0.001	0.0842	0.0842	126	19	70	0.31
Diesel	Passenger cars (Euro 2) [h]	0.716	0.296	0.035	0.001	0.0548	0.0548	126	19	80	0.18
Diesel	Passenger cars (Euro 3) [h]	0.773	0.089	0.02	0.001	0.0391	0.0391	126	19	85	0.12
Diesel	Passenger cars (Euro 4) [h]	0.58	0.092	0.014	0.001	0.0314	0.0314	126	19	87	0.1
Diesel	Passenger cars (Euro 5) [h]	0.61	0.04	0.008	0.0019	0.0021	0.0021	126	19	10	3.85
Diesel	Passenger cars (Euro 6) [h]	0.21	0.049	0.008	0.0019	0.0015	0.0015	126	19	20	1.54
Diesel	Light-commercial vehicles (Conventional) i	1.66	1.34	0.133	0.0012	0.356	0.356	225	34	55	0.54
Diesel	Light-commercial vehicles (Euro 1) i	1.22	0.577	0.141	0.0012	0.117	0.117	225	34	70	0.31
Diesel	Light-commercial vehicles (Euro 2) i	1.22	0.577	0.149	0.0012	0.117	0.117	225	34	80	0.18
Diesel	Light-commercial vehicles (Euro 3) i	1.03	0.473	0.094	0.0012	0.0783	0.0783	225	34	85	0.12
Diesel	Light-commercial vehicles (Euro 4) i	0.831	0.375	0.035	0.0012	0.0409	0.0409	225	34	87	0.1
Diesel	Light-commercial vehicles (Euro 5) i	0.622	0.075	0.035	0.0019	0.001	0.001	225	34	10	3.85
Diesel	Light-commercial vehicles (Euro 6) i	0.221	0.075	0.035	0.0019	0.0009	0.0009	225	34	20	1.54
Diesel	Heavy-duty vehicles (Conventional) [j]	8.92	2.13	0.776	0.0029	0.333	0.333	450	68	50	0.154
Diesel	Heavy-duty vehicles (HD Euro I) [j]	5.31	1.020	0.326	0.0029	0.129	0.129	450	68	65	0.154
Diesel	Heavy-duty vehicles (HD Euro II) [j]	5.5	0.902	0.207	0.0029	0.061	0.061	450	68	65	0.154
Diesel	Heavy-duty vehicles (HD Euro III) [j]	4.3	0.972	0.189	0.0029	0.0566	0.0566	450	68	70	0.154
Diesel	Heavy-duty vehicles (HD Euro IV) [j]	2.65	0.071	0.008	0.0029	0.0106	0.0106	450	68	75	0.154
Diesel	Heavy-duty vehicles (HD Euro V) [j]	1.51	0.071	0.008	0.011	0.0106	0.0106	450	68	75	0.154
Diesel	Heavy-duty vehicles (HD Euro VI) [j]	0.291	0.071	0.008	0.011	0.0005	0.0005	450	68	15	2.31
Diesel	Urban Buses (Conventional) [j]	16.5	5.710	1.990	0.0029	0.909	0.909	450	68	50	0.154
Diesel	Urban buses (HD Euro I) [k]	10.1	2.710	0.706	0.0029	0.479	0.479	450	68	65	0.154
Diesel	Urban buses (HD Euro II) [k]	10.7	2.440	0.463	0.0029	0.22	0.22	450	68	65	0.154
Diesel	Urban buses (HD Euro III) [k]	9.38	2.670	0.409	0.0029	0.207	0.207	450	68	70	0.154
Diesel	Urban buses (HD Euro IV) [k]	5.42	0.223	0.220	0.0029	0.0462	0.0462	450	68	75	0.154
Diesel	Urban buses (HD Euro V) [k]	3.09	0.223	0.220	0.0029	0.0462	0.0462	450	68	75	0.154
Diesel	Urban buses (HD Euro VI) [k]	0.597	0.223	0.220	0.0029	0.0023	0.0023	450	68	15	0.231

CNG	3-wheeler (Bharat 1 = Euro 1)	0.50 [B]	1.00 [B]	0.26 [B]	0.034	0.015 [B]	0.015 [B]	90	14		
CNG	3-wheeler Retrofit (Bharat 1 = Euro 1)	0.19 [B]	0.69 [B]	2.06 [B]	0.034	0.118 [B]	0.118 [B]	90	14		
CNG	Passenger car retrofit (moderate control)	0.53 [A]	0.85 [A]	0.79 [A]	0.034	0.001 [A]	0.001 [A]	126	19		
CNG	Passenger car retrofit (Bharat 1 = Euro 1)	0.01 [B]	0.60 [B]	0.36 [B]	0.034	0.002 [B]	0.002 [B]	126	19		
CNG	Passenger car (Euro 4 and later)	0.056	0.616	0.035	0.034	0.0011	0.0011	126	19		
CNG	Urban Bus (HD Euro I)	16.5	8.4	0.371	n.a.	0.02	0.02	450	68		
CNG	Urban Bus (HD Euro II)	15	2.7	0.313	n.a.	0.01	0.01	450	68		
CNG	Urban Bus (HD Euro III)	10	1	0.052	n.a.	0.01	0.01	450	68		
CNG	**Total for CNG**										
LPG	3-wheeler Retrofit (Moderate control) [A]	0.05 [A]	7.2 [A]	5.08 [A]	0.002 [E]	0.171 [A]	0.171 [A]	90	14		
LPG	3-wheeler Retrofit (Bharat 1 = Euro 1)	0.04 [B]	1.70 [B]	1.03 [B]	0.088 [E]	0.130 [B]	0.130 [B]	90	14		
LPG	Passenger cars (Conventional)	2.36	6.832	1.05	0.0020	0.0022	0.0022	126	19		
LPG	Passenger cars (Euro 1)	0.414	3.57	0.723	0.0880	0.0022	0.0022	126	19		
LPG	Passenger cars (Euro 2)	0.18	2.48	0.342	0.1007	0.0022	0.0022	126	19		
LPG	Passenger cars (Euro 3)	0.09	1.79	0.120	0.0338	0.0011	0.0011	126	19		
LPG	Passenger cars (Euro 4)	0.056	0.62	0.100	0.0338	0.0011	0.0011	126	19		
LPG	Passenger cars (Euro 5)	0.056	0.62	0.100	0.0338	0.0011	0.0011	126	19		
LPG	Passenger cars (Euro 6)	0.056	0.62	0.100	0.0338	0.0011	0.0011	126	19		
LPG	Light-duty vehicles (Uncontrolled)	2.1 [F]	8.0 [F]	3.5 [F]	0.002 [E]	0.0022 [E]	0.0022 [E]	225	34		
LPG	Light-duty vehicles (Good control - Euro-I)	0.05 [F]	0.3 [F]	0.25 [F]	0.088 [E]	0.0022 [E]	0.0022 [E]	225	34		
LPG	Heavy-duty vehicles (Uncontrolled)	5.7 [G]	24 [G]	8 [G]	0.004 [E]	0.0044 [E]	0.0044 [E]	450	68		
LPG	Heavy-duty vehicles (Good contro)	2.6 [G]	1.0 [G]	0.7 [G]	0.176 [E]	0.0044 [E]	0.0044 [E]	450	68		
LPG	**Total for LPG**										
Total											

* Emission factors are Tier 2 exhaust emission factors from EMEP/EEA (2013), Tables 3-16 to 3-25, unless otherwise indicated.

[a] Uncontrolled EFs = Tier 1 maximum value from EMEP/EEA (2013) converted assuming fuel economy from Table 3-14, EMEP/EEA, 2013

[b] Assume = Motorcycle 2-stroke (uncontrolled)

[c] Heavy duty vehicle, Gasoline, >3.5 t weight.

[d] Emission factors for Gasoline passenger cars (1.4 - 2.0 L engine capacity), Open loop technology (from EMEP/EEA (2013), Tables 3-16 and 3-17)

[e] Emission factors for Gasoline passenger cars (1.4 - 2.0 L engine capacity) from EMEP/EEA (2013) Tier 2 exhaust emission factors, Tables 3-16 and 3-17.

[f] Emission factors for 2-stroke motorcycles (>50 cm^3), 'Conventional' technology (from EMEP/EEA (2013), Tables 3-24 and 3-25)

[g] Emission factors for 4-stroke motorcycles (250 - 750 cm^3), 'Conventional' technology (from EMEP/EEA (2013), Tables 3-24 and 3-25)

[h] Emission factors for Diesel passenger cars (1.4 - 2.0 L engine capacity) from EMEP/EEA (2013) Tier 2 exhaust emission factors, Tables 3-16 and 3-17.

[i] Emission factors for Light Commercial Vehicles (<3.5 t weight) from EMEP/EEA (2013) Tier 2 exhaust emission factors, Tables 3-18 and 3-19.

[j] Emission factors for Heavy Duty Vehicles (7.5 - 16 t weight) from EMEP/EEA (2013) Tier 2 exhaust emission factors, Tables 3-20 and 3-21

[k] Urban buses standard - vehicles used for the carriage of passengers and comprising more than eight seats in addition to the driver's seat

[l] Assume PM2.5 EF = PM10 EF

[m] Derived from Gillies et.al. (2005) for unpaved rural roads in dry weather

[n] Assume $PM_{2.5}$ factor is 15% of PM_{10} factor (USEPA, 1995)

[o] EMEP/EEA (2013) Tier 3 fraction BC (%) and Organic matter (OM) to BC ratio (Table 3-114) assuming OM = 1.3xOC

[A] ARAI (2008) value for Indian fleet 1996-2000

[B] ARAI (2008) value for Indian fleet post 2000 (Bharat 1 = Euro 1)

[C] ARAI (2008) value for Indian fleet post 2005 (Bharat 2 = Euro 2)

[E] Assume LDV = passenger car; HDV = 2 x passenger car

[F] IPCC (1996) default EF for US LPG passenger cars

[G] IPCC (1996) default EF for US LPG uncontrolled heavy duty vehicles with stoichiometric engine

[H] Assume = LCV (Conventional)