

GHG Emission Factors Developed for the Energy Sector in India

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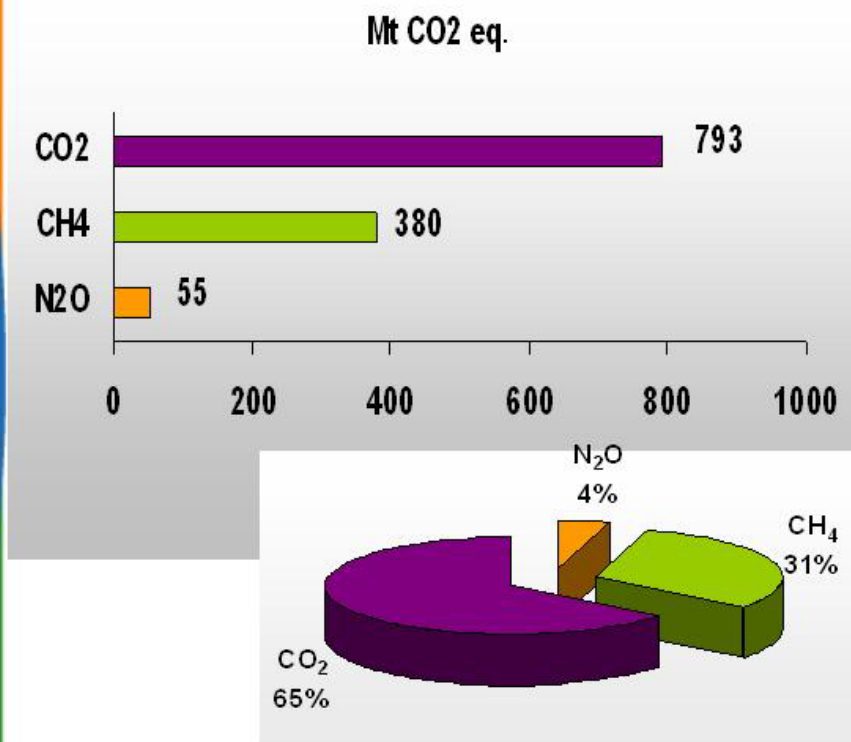


GHG Emissions from Sources and Removals by Sinks

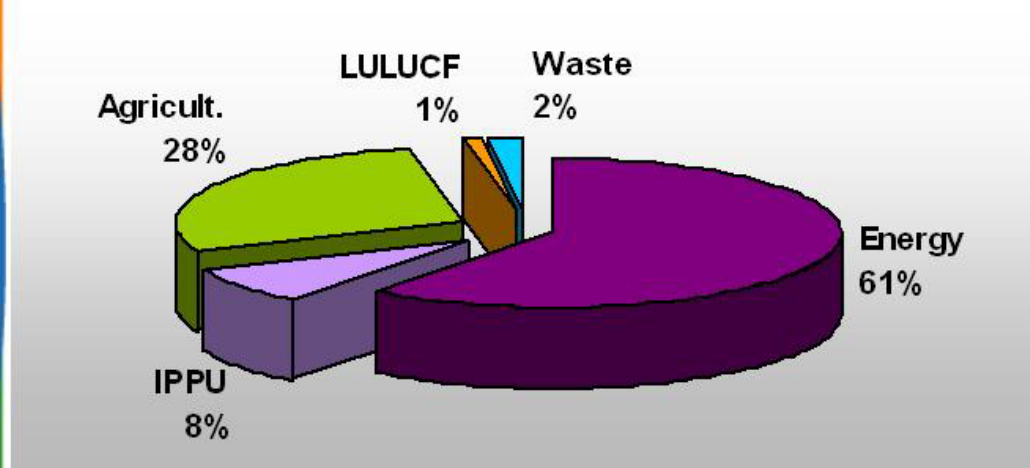
Total National Emissions (Gg/yr)	CO2 Emissions	CO2 Removals	CH4	N2O	CO2-eq.
All Energy	679470		2896	11.4	743820
Industrial Processes	99878		2	9	102710
Agriculture			14175	151	344485
LULUCF	37675	23533	0.04		14292
Waste			1003	7	23233
Bunker fuels	3373				3373
Total Emissions	817023	23533	18083	178	1228540



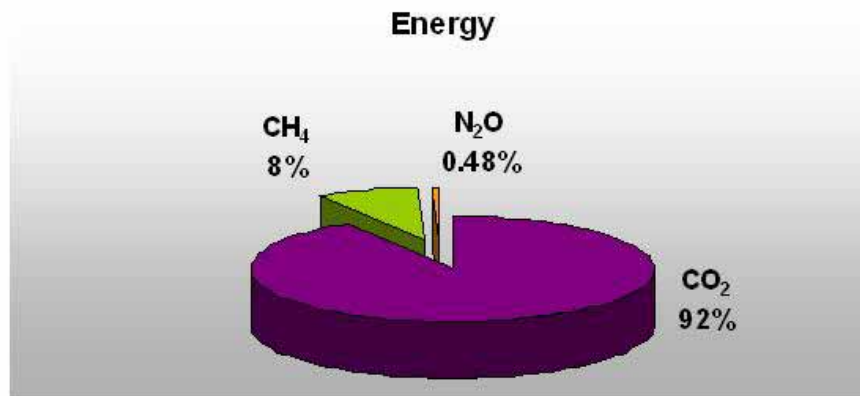
GHG Emission Distribution in India



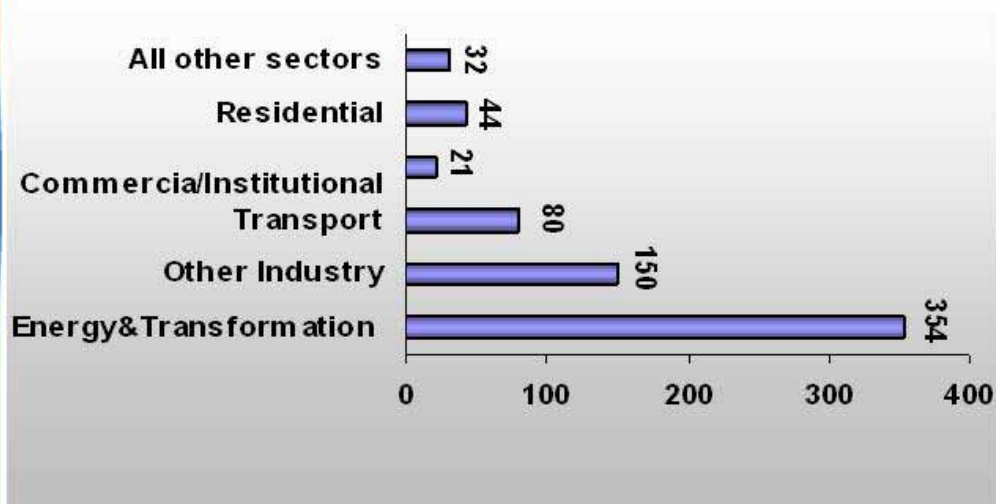
Sectoral GHG Emissions Distribution



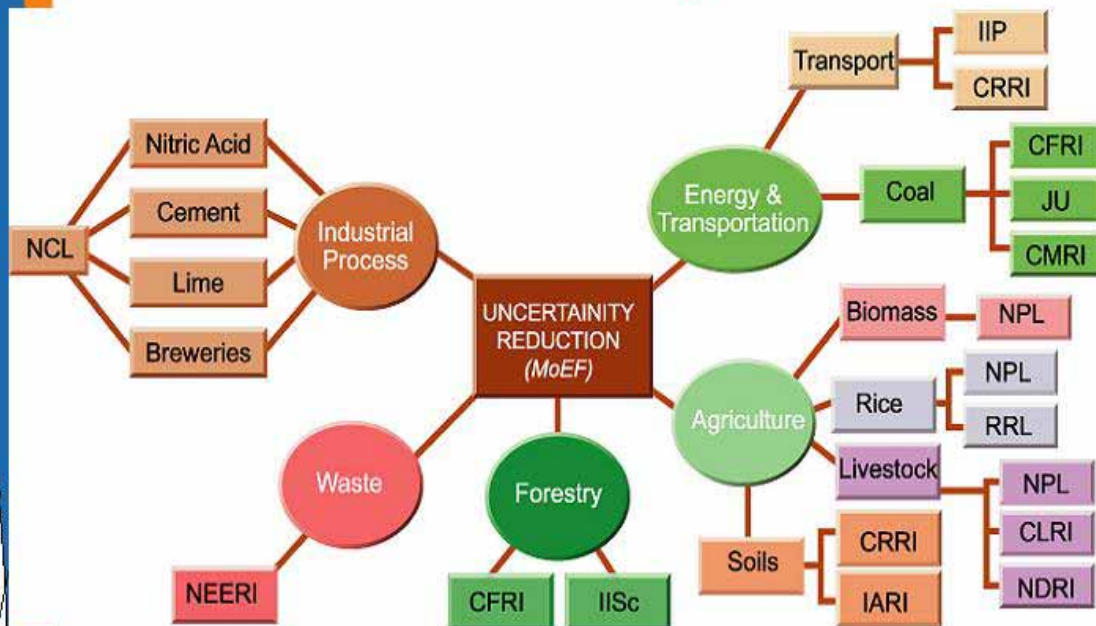
GHG Emission Distribution within Energy Sector



CO₂ Emissions by Categories in the Energy Sector (Mt)



Institutional Arrangement



17 Institutions



Some of the proposed activities for developing GHG inventories in the Energy Sector

Development of an energy balance matrix to ascertain energy flow across sectors

Measurement of Plant specific CO₂ EF

Refine NCV of coking, non coking and lignite consumed in thermal power plants

Refine the GHG emission estimates from the road transport sector

Develop methodology to generate data related to oil and natural gas venting, flaring, transmission and distribution



Key Category Analysis – Level Analysis

Sources of emission	CO ₂ equivalent (Gg)	Percentage of total emissions	Cumulative emission (Gg)	Cumulative emission vs total emission (%)	Tier used	EF used
Energy and transformation industries	355,037	28.9	355,037	28.9	Tier II	CS
Enteric fermentation	188,412	15.3	543,449	44.2	Tier III	CS
Fossil fuel combustion in industry	150,674	12.3	694,123	56.5	Tier I	D
Rice cultivation	85,890	7.0	780,013	63.5	Tier III	CS
Transport	80,286	6.5	860,299	70.0	Tier II	CS
Emission from soils	45,260	3.7	905,559	73.7	Tier I	D
Iron and steel production	44,445	3.6	950,004	77.3	Tier I	D
Energy use in residential sector	43,918	3.6	993,922	80.9	Tier I	D
Biomass burnt for energy	34,976	2.8	1,028,898	83.7	Tier I	D
All other energy sectors	32,087	2.6	1,060,985	86.4	Tier I	D
Cement production	30,767	2.5	1,091,752	88.9	Tier II	CS
Energy consumed in commercial-institutional	20,571	1.7	1,112,323	90.5	Tier I	D
Manure management	20,176	1.6	1,132,499	92.2	Tier I	D
Ammonia production	14,395	1.2	1,146,894	93.4	Tier I	D
Land use, land-use change and forestry	14,292	1.2	1,161,186	94.5	Tier II	CS

Key Sectors identified in the Energy Sector*

Category	Level analysis	EF Used in INC	SNC Improvement envisaged
Energy and transformation industries	29%	CS	R
Transport	6.5%	CS	R
Iron and steel	3.6%	D	CS

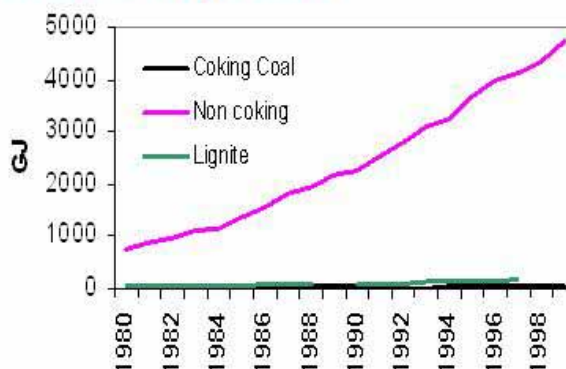
*Considering their high rates of growth in production in the last decade

Coal Consumption

Coal Consumption:

Coal Shall Remain India's Primary Energy Source till 2031-32,

Coal accounts for over 50% of India's commercial energy consumption and some 78% of domestic coal production is dedicated to power generation



It is recommended, to increase coal use efficiency in power generation from the current average of 30.5 percent to 39 percent for all new plants.

Introduction of clean coal technologies, improving energy efficiency, Renewable energy resources, hydro power, and various other measures is bringing down the CO₂ emission intensity from this sector.

Country specific EF Developed for Indian Coal

		Emission Factor (EF)	Reference
Indian Coal	NCV TJ/Kt	t CO ₂ /TJ	Choudhury et al., 2004
Coking coal	24.18±0.3	25.53	
Non-coking coal	19.63±0.4	26.13	
Lignite	9.69±0.4	28.95	

Source of Uncertainties in estimation of CO₂ EF from coal combustion

Activity Data

Carbon emission factor

- variation with the rank and type of coal
- Contribution from carbonates in high ash coals

Basis of CO₂ emission – NCV/GCV

- assumption of NCV being 5% less than GCV for any coal may not be correct. Variation can be 2% for anthracite to 10% for Lignite.
- may lead to underestimate of CO₂ from low rank and overestimate of CO₂ from high rank coals

Fraction of carbon oxidised

- coal & plant dependent.

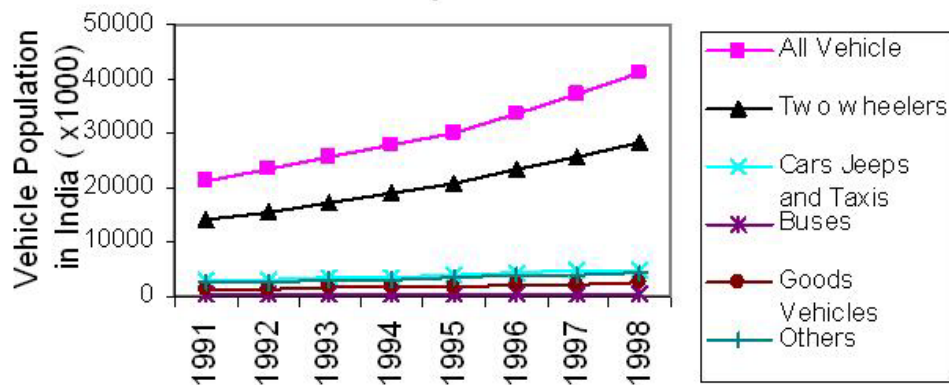
Refinement Being Considered for SNC-Combustion of Coal

Category	EF Used in INC	SNC Improvement	Activities proposed	Rationale
Coal	CS	R	Refinement of NCV	Inadequate sample size
Power Plant	-	CS	Determine point source specific CO ₂ , NO _x and CO EFs	Thermal power plants- key source

Transport Sector

India has seen a rapid growth in the vehicle population

Vehicle Population in India



Transport Sector – e.g. of growth rates in Delhi

S.No.	Category	Vehicles registered (In lakh)		Decadal growth rate % (1993-94 to 2003-04)	Annual Compound Growth rate %
		1993-94	2003-04		
A.	Private Vehicles				
	Four wheelers (Cars, Jeeps, St. Wagon)	5.22	12.68	142.92	9.27
ii.	Two wheelers (Scooter, Motorcycle)	14.92	26.50	77.61	5.91
	Sub-Total	20.14	39.18	94.54	6.64
B.	Commercial Vehicles				
iii.	Auto-Rickshaw	0.72	0.75	4.17	0.38
iv.	Taxis	0.12	0.16	33.33	3.09
v.	*Buses	0.24	0.39	62.50	4.84
vi.	Goods Vehicle	1.17	1.36	16.24	1.55
	Sub-Total	2.25	2.66	18.22	1.69
	Total	22.39	41.84	86.87	6.45

Country specific EF Developed for Road Transport Sector

		Emission Factor (EF)	Reference
Road Transport sector		TCO/Tj	
Gasoline	2W/3W	43.9 ± 7.3	Singh et al., 2004a, Singhal et al, 2004
	Car/Taxi	61.5 ± 4.0	
Diesel Oil	MCV/HCV	71.4 ± 0.55	
	LCV	71.4 ± 0.5	

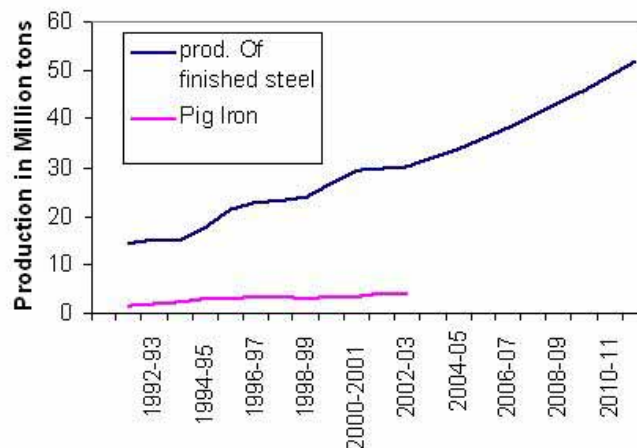
Sources of Uncertainty in the Road Transport Sector

- Activity data
 - The vehicle population by type
 - Diesel/petroleum consumed by each vehicle type
 - Details of other fuel consumed
 - Kilometer traveled by each type of vehicle (reflecting the driving cycle)

Refinement Being Considered for SNC-Transport Sector

Category	EF Used in INC	SNC Improvement	Activities proposed	Rationale
Transport		CS	Surveys to apportion fuel used in various types of vehicles	Reconcile the top down with the bottom up approach
	CS Fuel based	CS	EFs using driving cycle	

Steel Sector



Between 1990-1991, steel prod. Grew by 7.6 % and it is expected to grow by 6.5% per annum upto 2012

However, considering a boom in infrastructure, the prod. Capacity is likely to increase with mega steel prod. Projects coming up



Sources of uncertainty in estimating CO₂ EF from steel sector

Emission from reducing agent (coal, coke) in blast furnace (BF), EAF, Sinter Strand

CO₂ emission from calcinations of carbonate fluxes in BF, EAF, SS

CO₂ emission from steel production in Basic oxygen furnace (BOF) or EAF - Plant specific technologies

Emission from on site combustion of carbon bearing products – Coke oven Gas/ Blast Furnace Gas

Emission due to combustion of other fossil fuel (e.g. from on site power production)

Activities planned for developing CS EF of CO₂ from Iron and Steel Sector

Separate out emissions from

- reducing agent

- calcination of carbonate fluxes

- CO₂ emission from technology specific steel production – BOF/ EAF

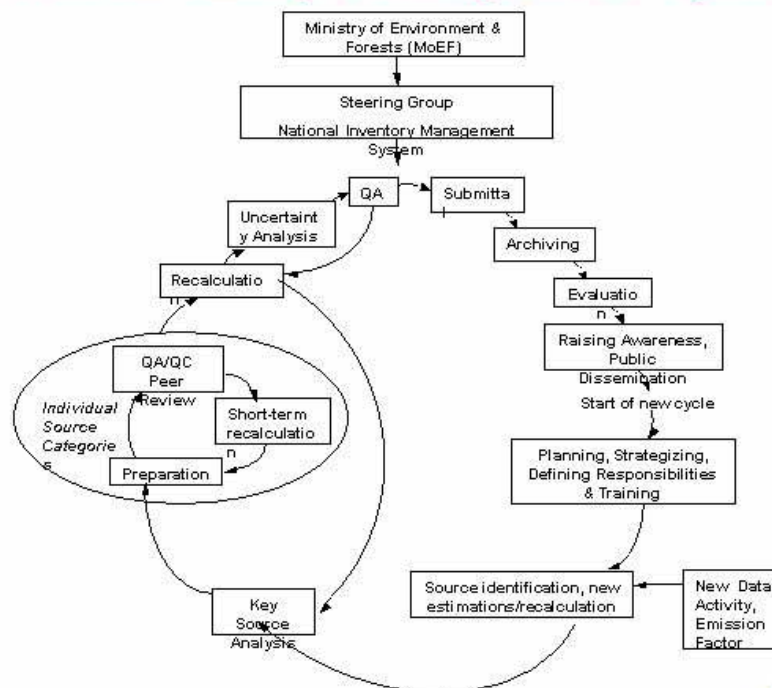
- Assess emission from on site combustion of carbon bearing products – Coke oven Gas/ Blast Furnace Gas

- Assess emission due to combustion of other fossil fuel (e.g. from on site power production)

Refinement Being Considered for SNC- Iron and Steel Sector

Category	EF Used in INC	SNC Improvement	Activities proposed	Rationale
Iron and Steel	D	CS	Plant specific CO ₂ EF assessment Assessment of Carbon content of Coke CO ₂ EF measurement	It is a fast growing sector of the economy in addition to being a major source of CO ₂ emission

National Inventory Management System





National Inventory Management System

NIMS will address the requirements of documentation, archiving and continuous updating of the databases as well as the QA/QC and uncertainty management issues of the inventory. A separate steering group will be instituted to oversee the operations of the NIMS and provide technical guidance.

- Develop systemic tools and procedures
 - procedures for documenting methodologies,
 - creating a database of emissions factors, activity data and assumptions;
 - data management and collection;
 - strategies for data generation and improvement;
 - systems for data archiving and record keeping;
 - mechanisms for synchronization and cross-feeding between emission inventories, national energy balances and relevant sector surveys;
 - guidance for technical peer reviews, procedures for QA/QC and uncertainty management.

- Design for dissemination of information through web-based management system.