Emissions Trends and Key Sources of Short-lived Climate Pollutants Using Top-down/Technology Based Methodologies in Mexico

Luis Gerardo Ruiz Suárez

IPCC Expert Meeting on Short-Lived Climate Forcers
May 28-31, Geneva

Main sources of information in this presentation

- Semarnat (2012). México Quinta Comunicación Nacional ante la Convención Marco de las Naciones Unidas sobre el Cambio Climático. Ciudad de México.
- MCE2 and INECC (2016). Integrated responses to short lived climate forcers promoting clean energy and energy efficiency. Mexico City, Molina Center for Energy and the Environment,Instituto Nacional de Ecología y Cambio Climático.
- INECC/Semarnat (2015). Primer Informe Bienal de Actualización ante la Convención Marco de las Naciones Unidas sobre el Cambio Climático. INECC. Ciudad de México, Instituto Nacional de Ecología y Cambio Climático. Periférico: 288.

Mexico Fifth Communication

A GEF project

1 Biennial Update Report

Some obviousness

- If SLCF are to included in climate conventions their emissions inventories need to be as:
  - transparent
  - documented
  - consistent over time,
  - complete
  - comparable
  - assessed for uncertainties
  - subject to quality control and assurance.
- Their emissions inventories should not mean heavy additional burdens to national emissions systems.
- Their emissions inventories should be estimated at the same tier level as co-emited Kyoto GHG for any sector source.
- SLCF emissions inventories should follow Good Practice IPCC Guidance at the same level as the co-emitted Kyoto GHG

BC national emission inventory in the Fifth National Communication

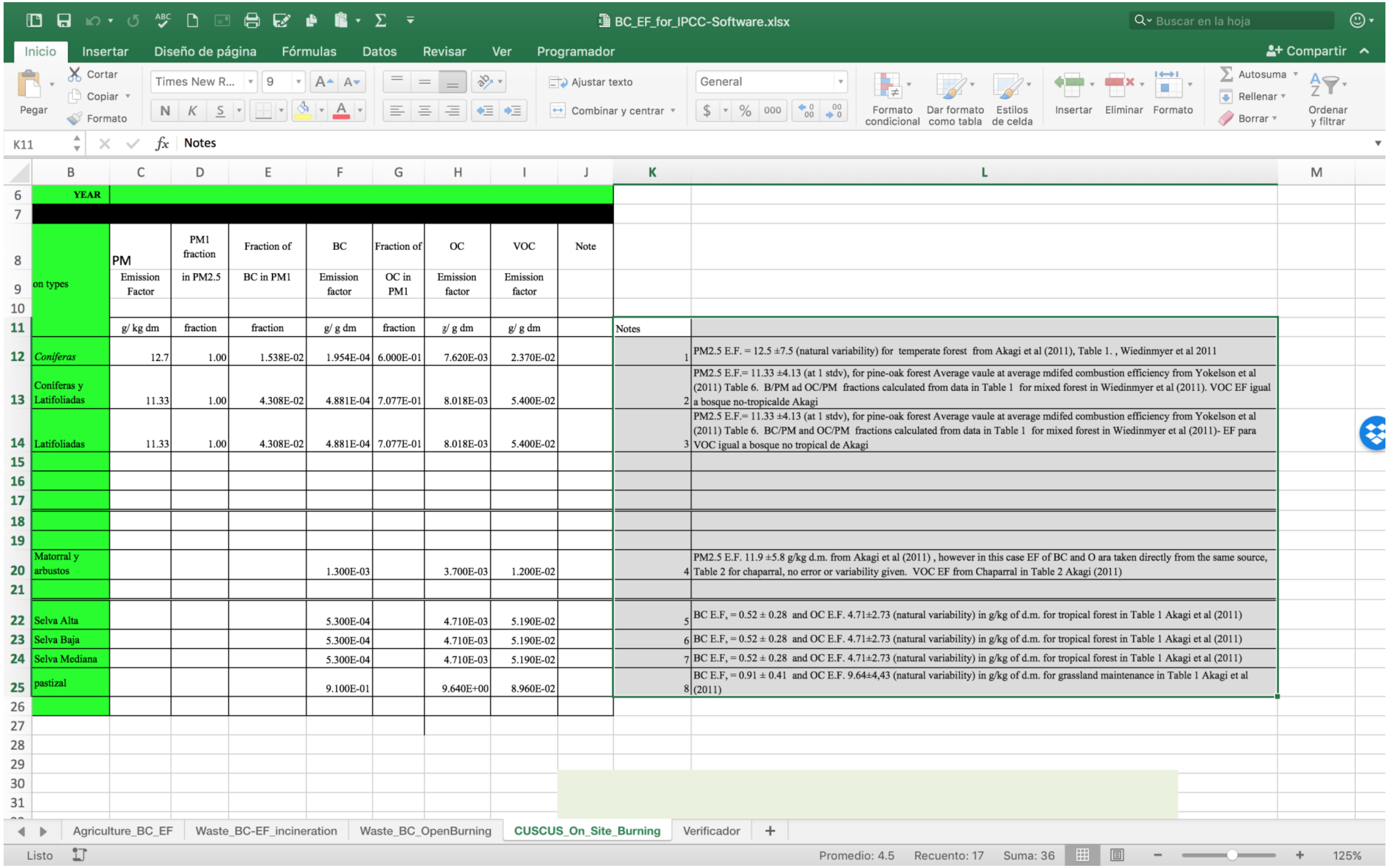
How it was made

- A proposal was made to INECC to make it piggybacked to the national GHG emissions inventory.
- We asked for the calculation files for all sectoral sources once the GHG emissions inventory was finished. We got:
    - Energy Sector: Proprietary Excel notebook for end use of fuel by sector with activity data from the national energy balance reports.
    - Waste Sector: 2006 IPCC Revised Guidelines
    - All other sectors; 1996 IPCC Guidelines
- Following Good Practice, use national emissions factors were used when available (forest fires, agricultural, waste open, cookstoves, brick)

How it was made, cont.

- Whenever there was combustion reported there should be BC and OC with the same activity data.
- For the energy sector follow Bond et al (2204) technology based estimation method.
  - Use Bond E.F. tables as default E.F.
  - If not in Bond´s tables, follow Bond as example and seek in literature.
  - Use weighted E.F. for mixed technologies use
  - Account for bad emitters for all internal combustion
  - Assume all domestic wood combustion is ”fogón” like.
- Estimate uncertainty using the same uncertainty for activity data as the co-emitted CO (CO_2) and the specific E.F.

Centralized emission factors file

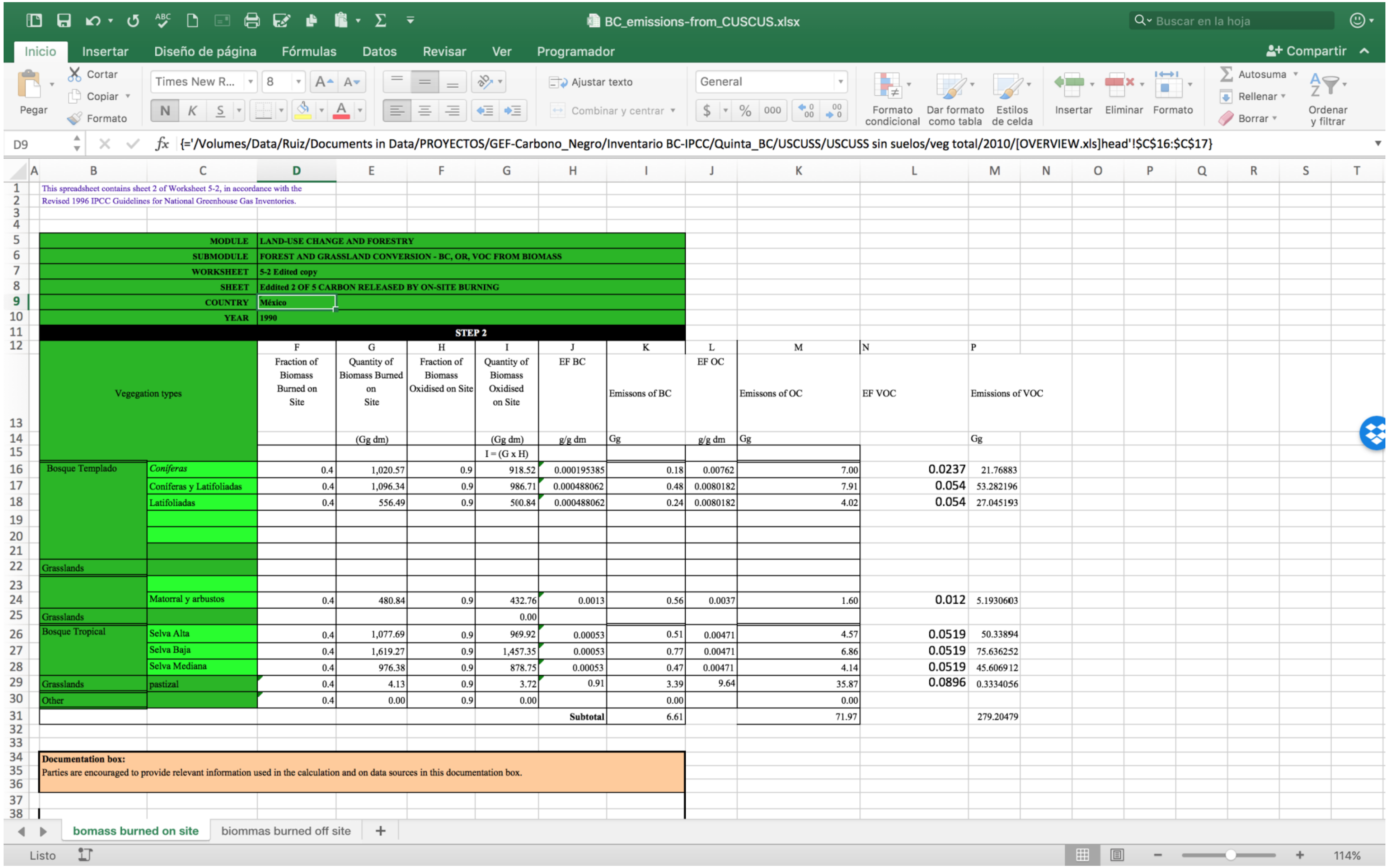


	PM Emission Factor	PM1 fraction in PM2.5	Fraction of BC in PM1	BC Emission factor	Fraction of OC in PM1	OC Emission factor	VOC Emission factor	Note
YEAR								
on types	g/ kg dm	fraction	fraction	g/ g dm	fraction	g/ g dm	g/ g dm	
Coniferas	12.7	1.00	1.538E-02	1.954E-04	6.000E-01	7.620E-03	2.370E-02	
Coniferas y Latifoliadas	11.33	1.00	4.308E-02	4.881E-04	7.077E-01	8.018E-03	5.400E-02	
Latifoliadas	11.33	1.00	4.308E-02	4.881E-04	7.077E-01	8.018E-03	5.400E-02	
Matorral y arbustos				1.300E-03		3.700E-03	1.200E-02	
Selva Alta				5.300E-04		4.710E-03	5.190E-02	
Selva Baja				5.300E-04		4.710E-03	5.190E-02	
Selva Mediana				5.300E-04		4.710E-03	5.190E-02	
pastizal				9.100E-01		9.640E+00	8.960E-02	

Notes	
1	PM2.5 E.F. = 12.5 ±7.5 (natural variability) for temperate forest from Akagi et al (2011), Table 1. , Wiedinmyer et al 2011
2	PM2.5 E.F.= 11.33 ±4.13 (at 1 stdv), for pine-oak forest Average vaule at average mdifed combustion efficiency from Yokelson et al (2011) Table 6. B/PM ad OC/PM fractions calculated from data in Table 1 for mixed forest in Wiedinmyer et al (2011). VOC EF igual a bosque no-tropicalde Akagi
3	PM2.5 E.F.= 11.33 ±4.13 (at 1 stdv), for pine-oak forest Average vaule at average mdifed combustion efficiency from Yokelson et al (2011) Table 6. BC/PM and OC/PM fractions calculated from data in Table 1 for mixed forest in Wiedinmyer et al (2011)- EF para VOC igual a bosque no tropical de Akagi
4	PM2.5 E.F. 11.9 ±5.8 g/kg d.m. from Akagi et al (2011) , however in this case EF of BC and O ara taken directly from the same source, Table 2 for chaparral, no error or variability given. VOC EF from Chaparral in Table 2 Akagi (2011)
5	BC E.F, = 0.52 ± 0.28 and OC E.F. 4.71±2.73 (natural variability) in g/kg of d.m. for tropical forest in Table 1 Akagi et al (2011)
6	BC E.F, = 0.52 ± 0.28 and OC E.F. 4.71±2.73 (natural variability) in g/kg of d.m. for tropical forest in Table 1 Akagi et al (2011)
7	BC E.F, = 0.52 ± 0.28 and OC E.F. 4.71±2.73 (natural variability) in g/kg of d.m. for tropical forest in Table 1 Akagi et al (2011)
8	BC E.F, = 0.91 ± 0.41 and OC E.F. 9.64±4,43 (natural variability) in g/kg of d.m. for grassland maintenance in Table 1 Akagi et al (2011)

This E.F. notebook is pasted into the IPCC software root

LULUC example



This spreadsheet contains sheet 2 of Worksheet 5-2, in accordance with the
Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.

MODULE	LAND-USE CHANGE AND FORESTRY
SUBMODULE	FOREST AND GRASSLAND CONVERSION - BC, OR, VOC FROM BIOMASS
WORKSHEET	5-2 Edited copy
SHEET	Eddited 2 OF 5 CARBON RELEASED BY ON-SITE BURNING
COUNTRY	México
YEAR	1990

STEP 2

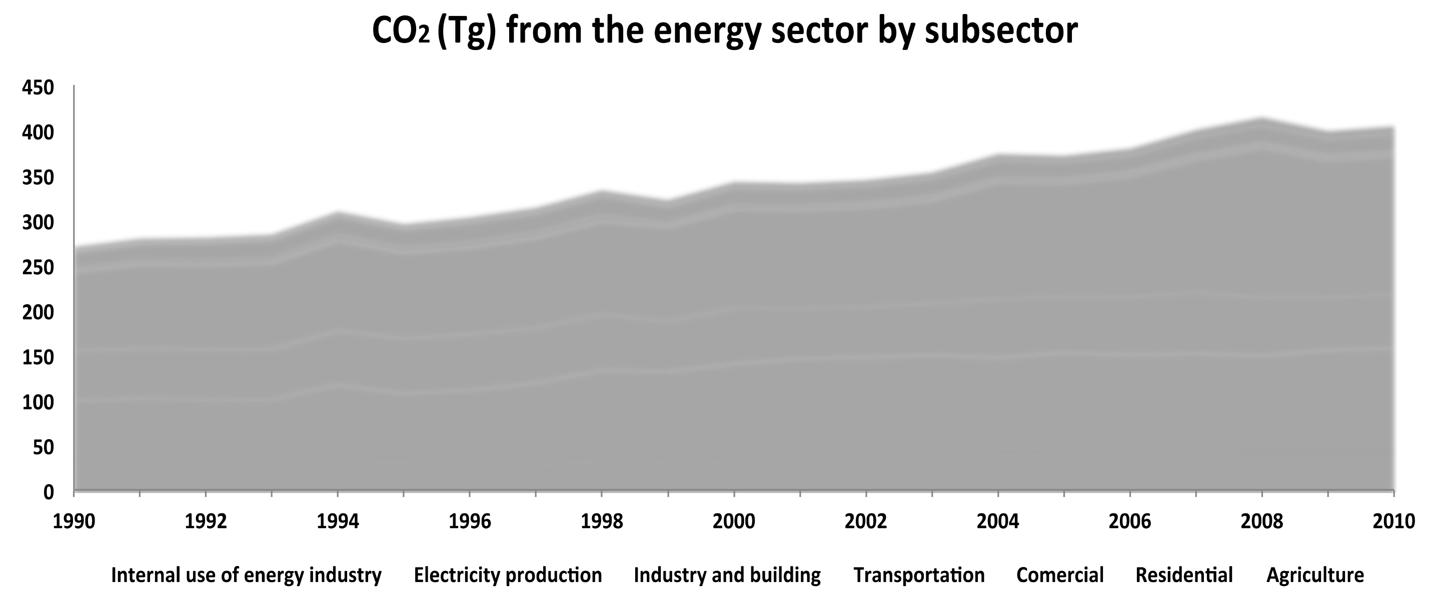
Vegegation types		F	G	H	I	J	K	L	M	N	P
		Fraction of Biomass Burned on Site	Quantity of Biomass Burned on Site	Fraction of Biomass Oxidised on Site	Quantity of Biomass Oxidised on Site	EF BC	Emissons of BC	EF OC	Emissons of OC	EF VOC	Emissions of VOC
			(Gg dm)		(Gg dm)	g/g dm	Gg	g/g dm	Gg		Gg
					I = (G x H)						
Bosque Templado	Coniferas	0.4	1,020.57	0.9	918.52	0.000195385	0.18	0.00762	7.00	0.0237	21.76883
	Coniferas y Latifoliadas	0.4	1,096.34	0.9	986.71	0.000488062	0.48	0.0080182	7.91	0.054	53.282196
	Latifoliadas	0.4	556.49	0.9	500.84	0.000488062	0.24	0.0080182	4.02	0.054	27.045193
Grasslands											
	Matorral y arbustos	0.4	480.84	0.9	432.76	0.0013	0.56	0.0037	1.60	0.012	5.1930603
Grasslands					0.00						
Bosque Tropical	Selva Alta	0.4	1,077.69	0.9	969.92	0.00053	0.51	0.00471	4.57	0.0519	50.33894
	Selva Baja	0.4	1,619.27	0.9	1,457.35	0.00053	0.77	0.00471	6.86	0.0519	75.636252
	Selva Mediana	0.4	976.38	0.9	878.75	0.00053	0.47	0.00471	4.14	0.0519	45.606912
Grasslands	pastizal	0.4	4.13	0.9	3.72	0.91	3.39	9.64	35.87	0.0896	0.3334056
Other		0.4	0.00	0.9	0.00		0.00		0.00		
						Subtotal	6.61		71.97		279.20479

Documentation box:
Parties are encouraged to provide relevant information used in the calculation and on data sources in this documentation box.

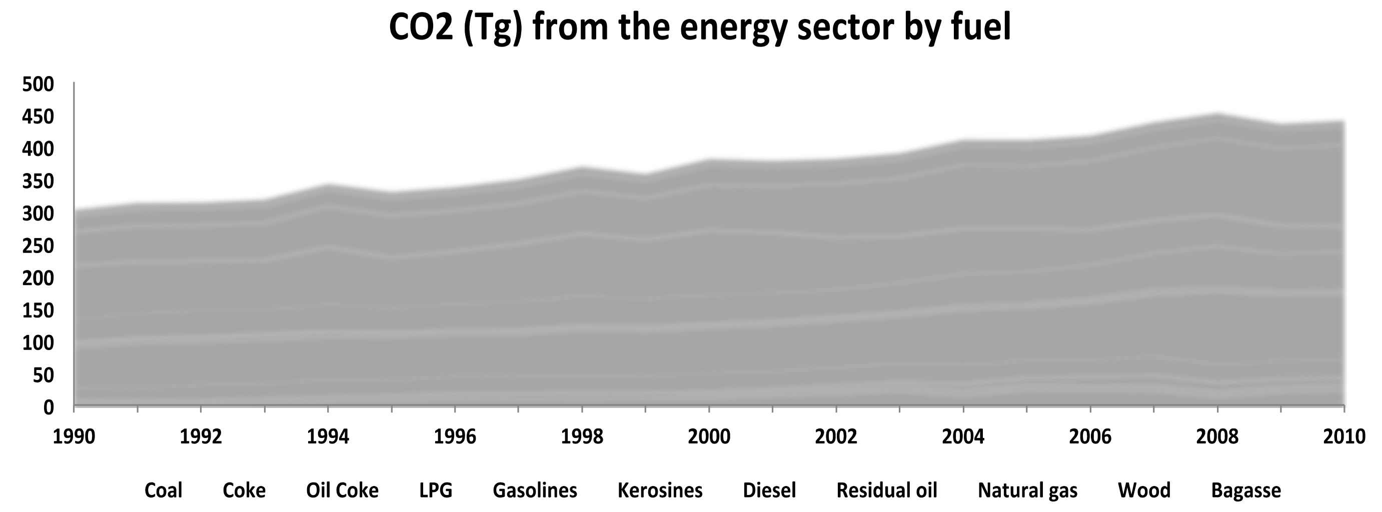
bomass burned on site | biommas burned off site

This notebook is pasted into the inventory year folder

To get started, from the GHG emissions inventory of the 5ft National Communication



CO2 emissions trends are quite stable by sector and by fuel, their shares do not change abruptly along the time as expected from the long life cycle of technologies in the main sectoral sources



Only natural gas use grows faster than other fuels at the expenses of residual oil in the electricity production

Emissions trends of BC and OC in Mexico

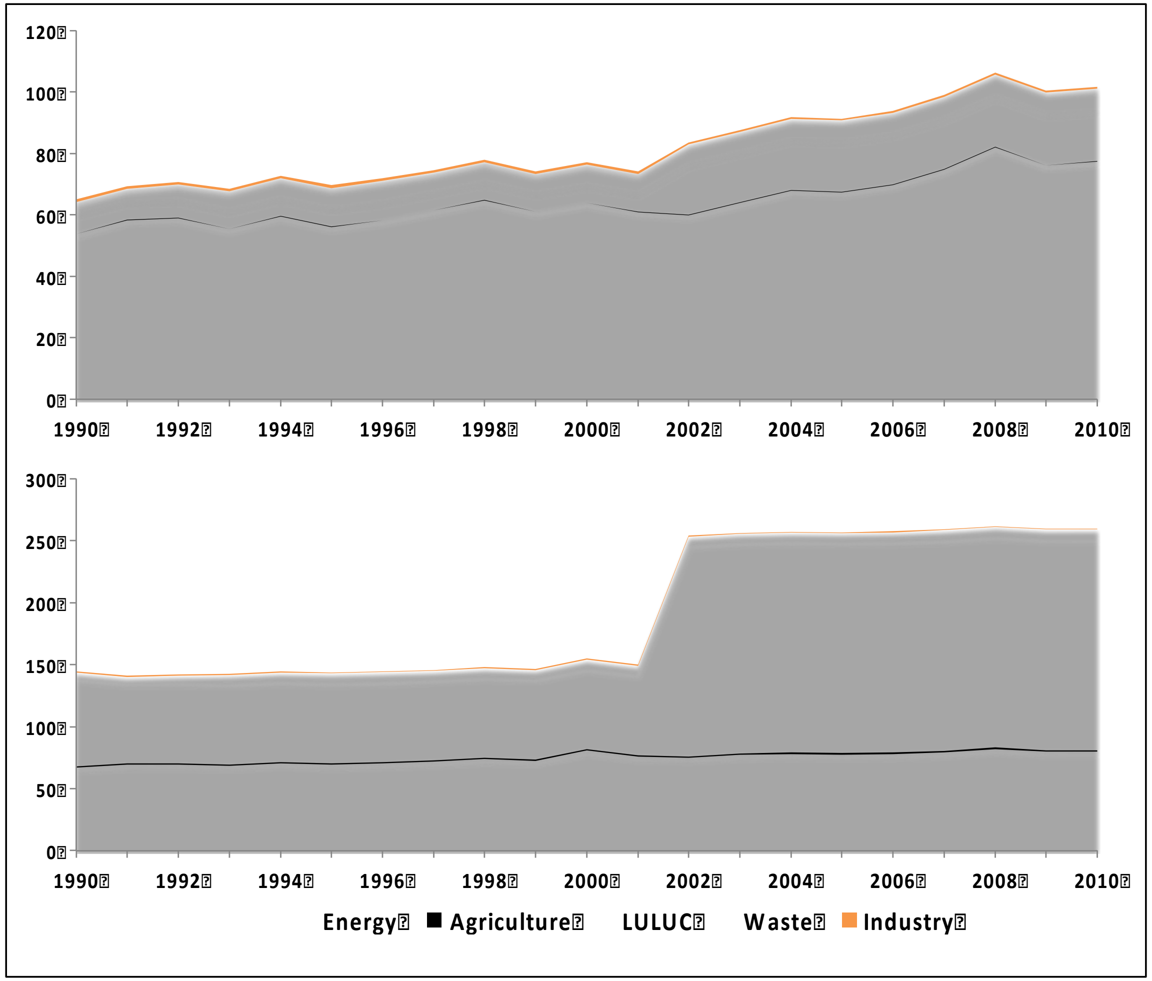


Figure A10. BC (top panel) and OC (bottom panel) emission trends from 1990 to 2010. Source of activity data, the 1990-2010 INEGEI in the Fifth National Communication, [SEMARNAT, 2012].

An oddity

GHG emissions from LULUC use deforestation rate from the National Forestry Inventory (NFI) as data source for the emissions activity data

These time series contains data from three NFI:

1981-1990,
1991-2000,
2001-2010

The GHG LULUC emissions inventory team took deforestation rates as they were from the NFI

I took the activity data as they were from the GHG emissions inventory from LULUC.

Relative sectoral contributions to BC and OC at the beginning and end of the time series

BC

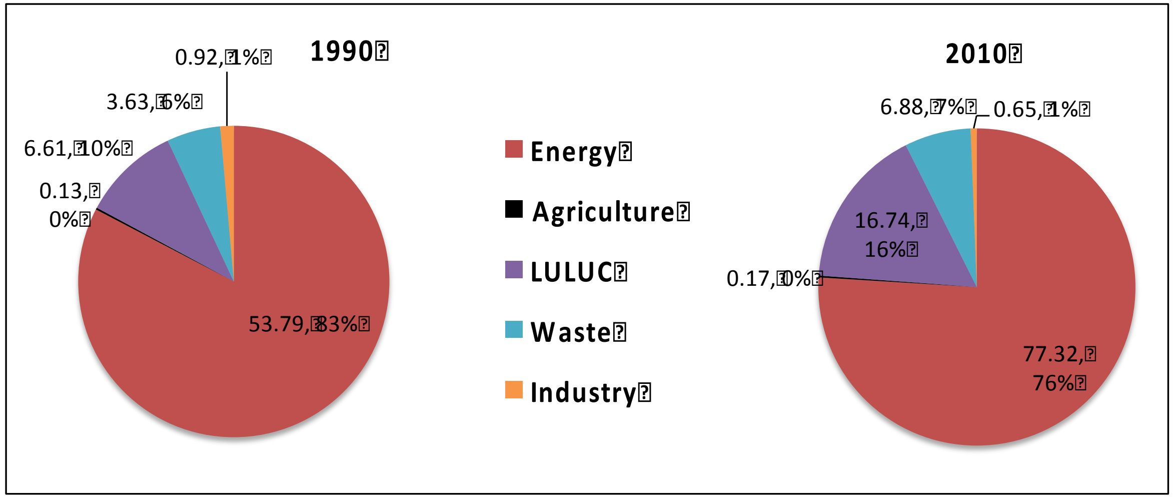


Figure A8. Relative distribution of BC by sector in 1990 and 2010.

OC

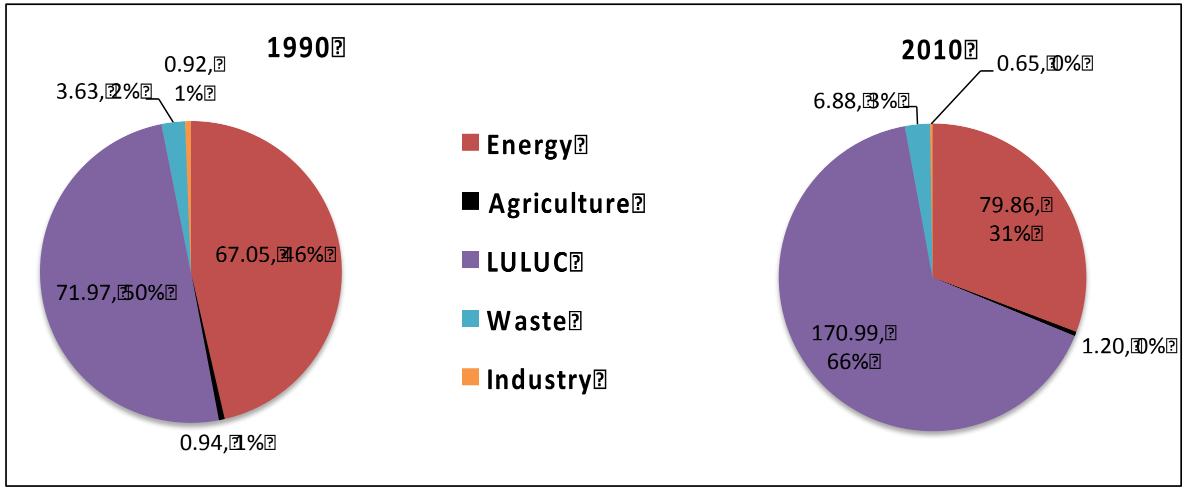
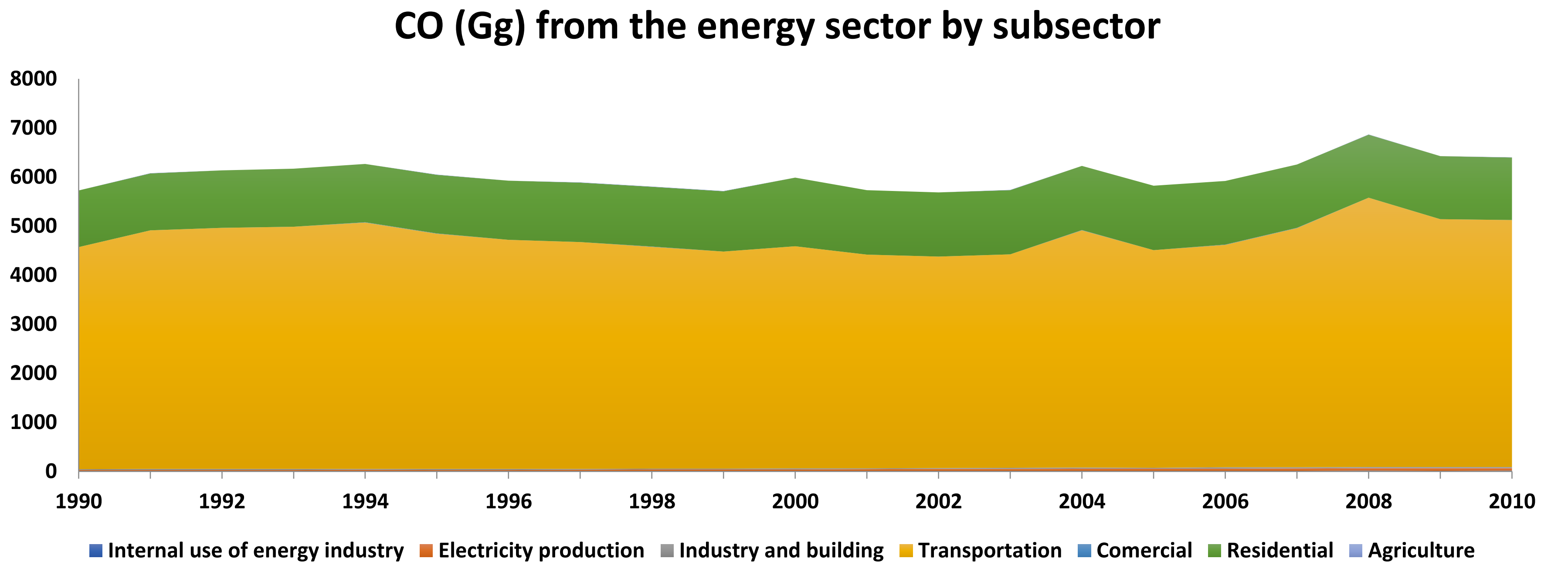


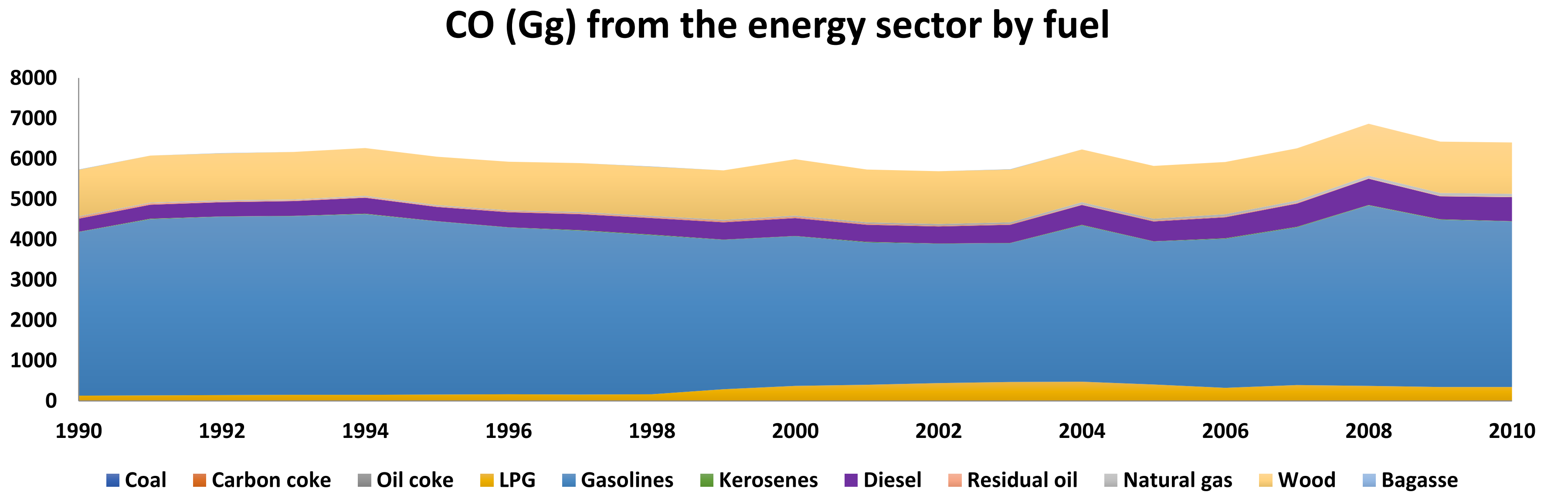
Figure A9. Relative distribution of OC by sector in 1990 and 2010.

In LULUC OC emissions ≃ 10 BC emissions

In open combustion VOC and OC emissions are correlated

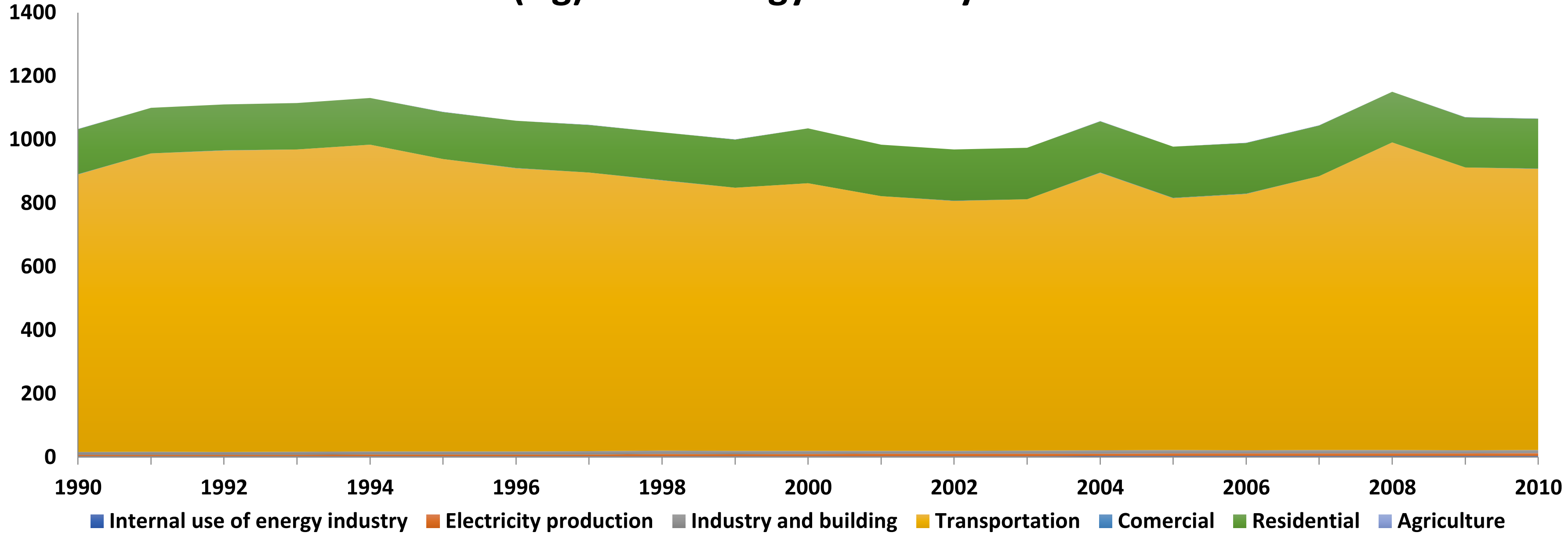


CO (Gg) from the energy sector by subsector
8000
7000
6000
5000
4000
3000
2000
1000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Internal use of energy industry
Electricity production
Industry and building
Transportation
Comercial
Residential
Agriculture

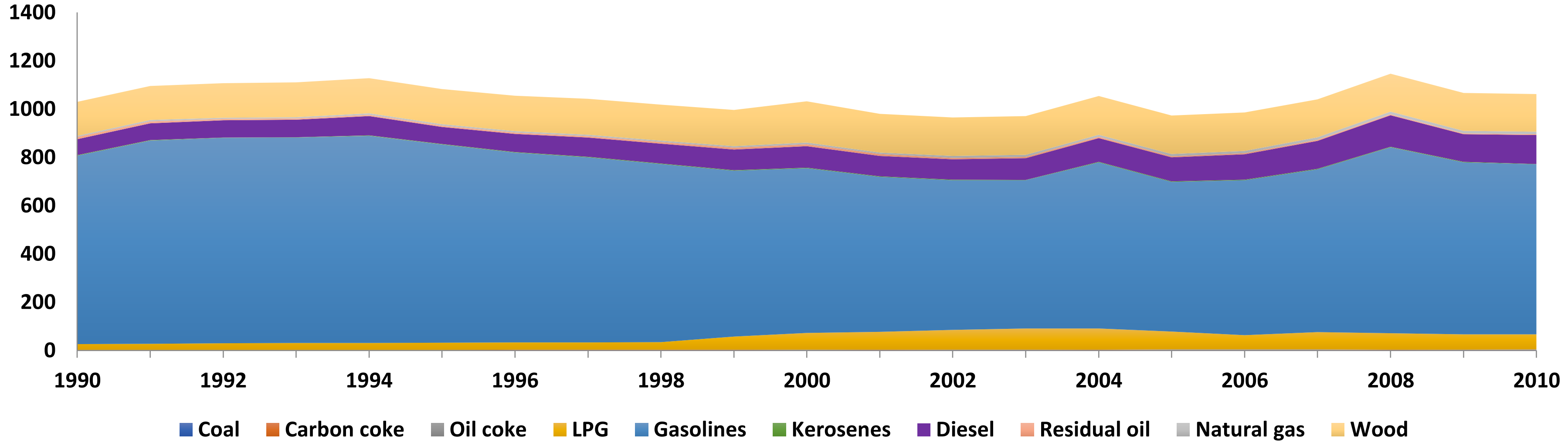


CO (Gg) from the energy sector by fuel
8000
7000
6000
5000
4000
3000
2000
1000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Coal
Carbon coke
Oil coke
LPG
Gasolines
Kerosenes
Diesel
Residual oil
Natural gas
Wood
Bagasse

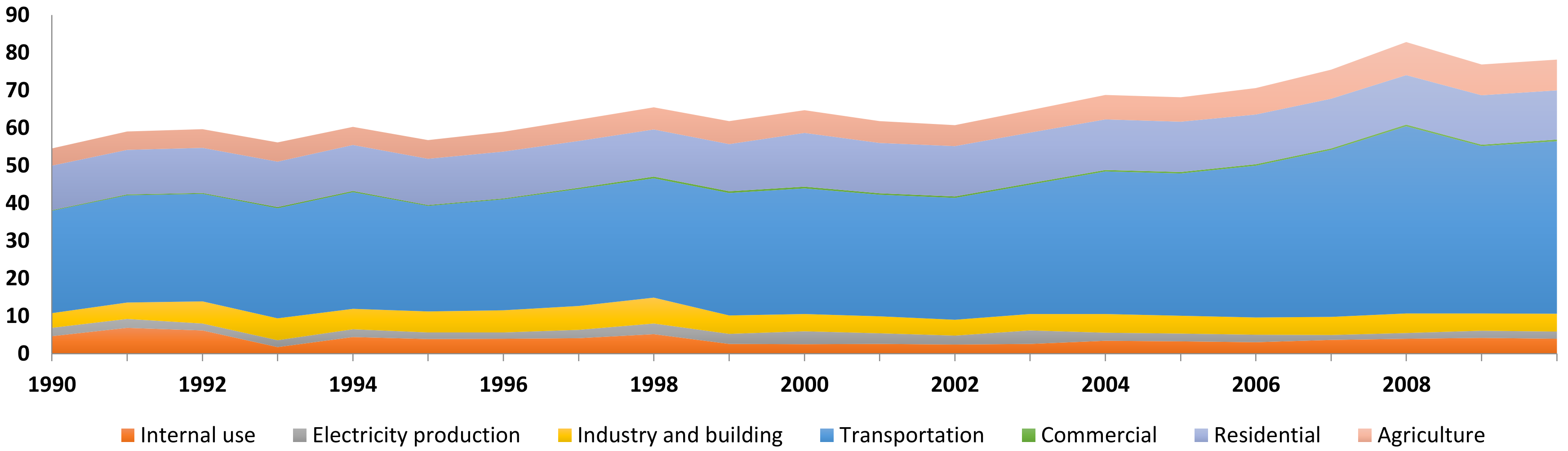
VOC (Gg) from energy sector by subsector



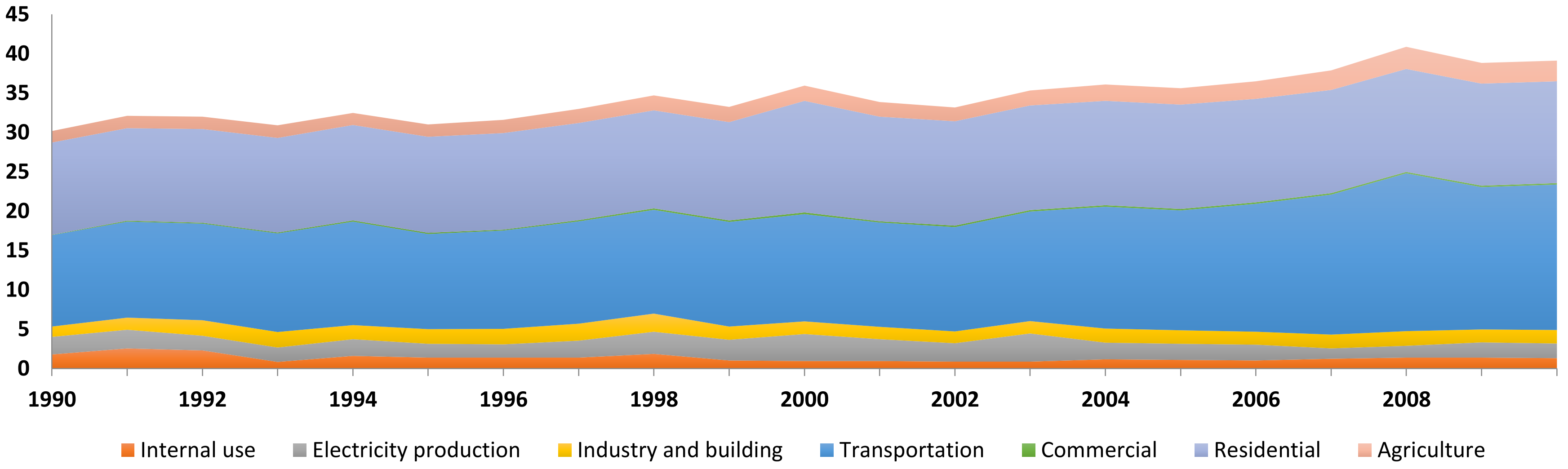
VOC (Gg) from the energy sector by fuel

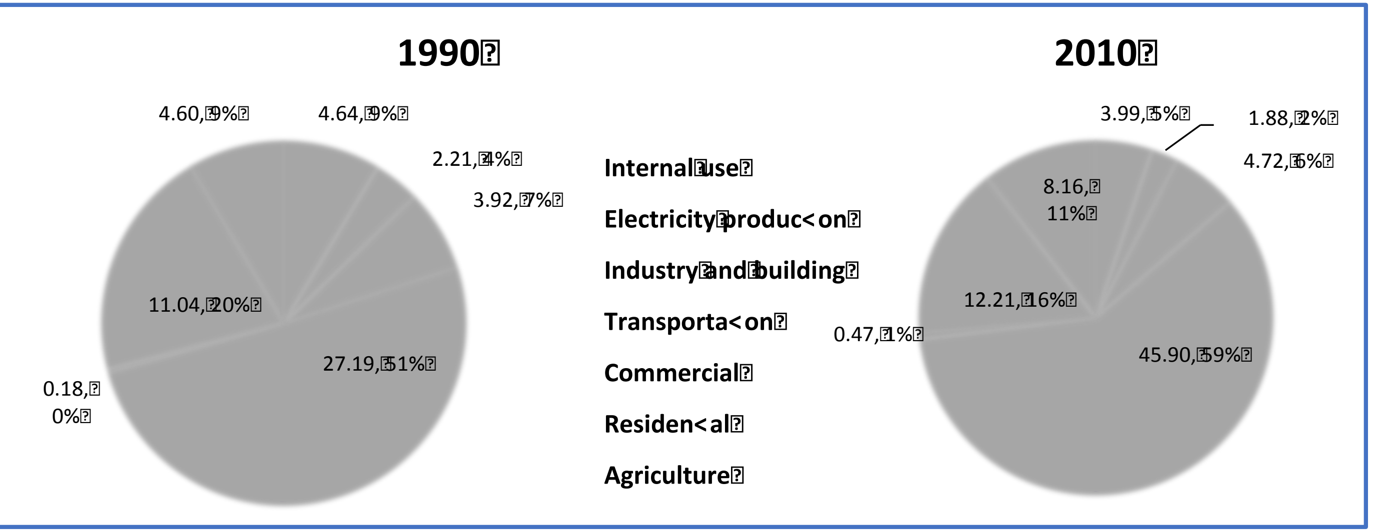


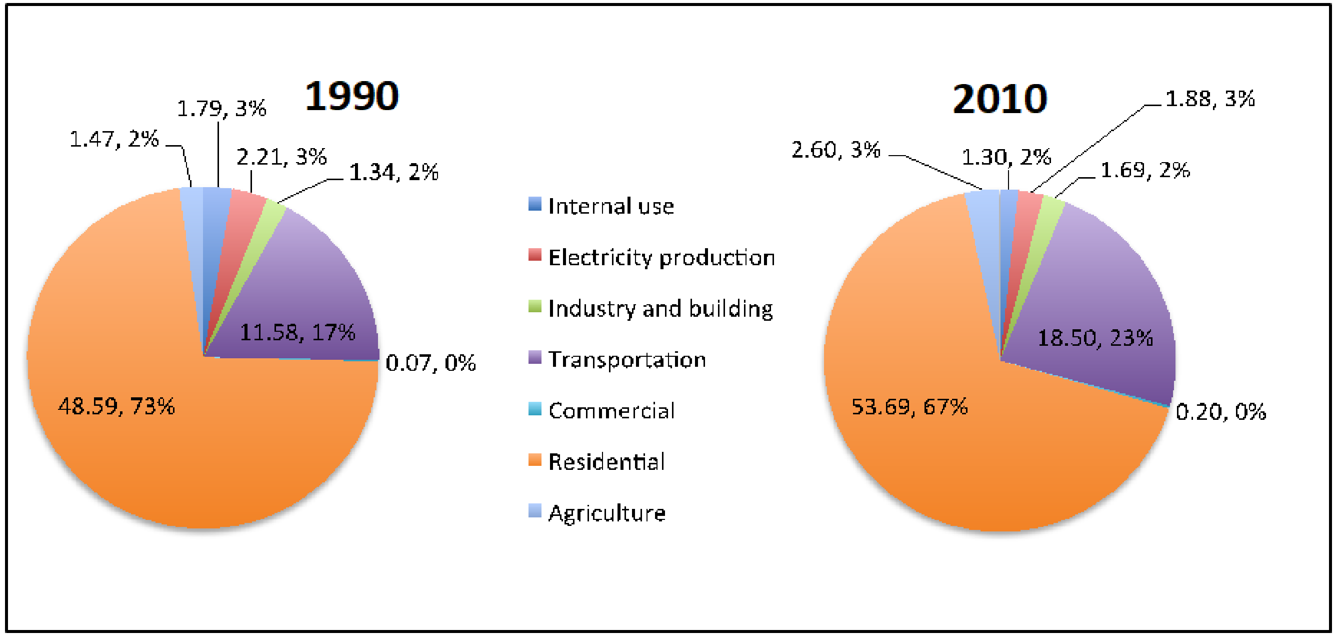
1990-2010 BC (Gg) from the energy sector by subsector



1990-2010 OC (Gg) from the energy sector by subsector







If in open combustion VOC and OC are correlated then VOC residential emissions may be as important as OC emissions.

Combustion SLCF should be analyzed as an integral set of co-pollutants

Comparison of total and sectoral BC emissions from the 5NC, 1rst BRP and 6NC for 2010.

	5NC		1rts BRP		6NC (2nd BRP)	
Energy	87.87	78%	112.40	90%	109.36	95%
Agriculture	0.17	0%	8.84	7%	3.51	3%
LULUC	16.74	15%	3.61	3%	0.75	1%
Waste	6.88	6%	0.23	0%	1.60	1%
Industrial Processes	0.47	1%	0.04	0%	0.00	0%
Totals	112.31		125.08		115.22	

BRP and 6 NC use BC/$PM_{2.5}$ ratios on 3$PM_{2.5}$ estimates of dectoral and bottom up estimates

Comparison of total and subsectoral BC emissions from the Energy Sector in the 5NC, 1rst BRP and 6NC for 2010

	5NC		1 BRP		6NC	
Industry of energy	3.99	1.5%	2.17	2%	1.59	1%
Electricity production	1.88	2%	8.46	8%	7.46	7%
Industry + building	4.72	5%	35.42	31%	27.27	25%
Transportation	45.9	52%	47.34	42%	29.34	27%
Commercial	0.47	1%	0.04	0%	2.37	2%
Residential	13.04	15%	18.98	17%	31.47	29%
Agriculture	8.16	9%	0.04	0%	0.31	0%
Fugitive emissions*	9.54	11%	0.00	0%	9.54	9%
Total	87.695		112.45		109.358	

Absolute and relative differences of BC missions between in the energy sector for 2010.

	6NC/5NC	6NC-5NC
Subsector		Gg
Energy industry	0.40	-2.40
Electricity production	3.97	5.58
Industry + building	5.78	22.55
Transportation	0.64	-16.56
Commercial	5.09	1.90
Residential	2.41	18.43
Agriculture	0.04	-7.85
Fugitive emissions	1.00	0.00

Conclusions

- Combustion SLCF emissions inventories can be made in the same go as GHG emission inventories
- Chosen E.F. (or BC/$PM_{2.5}$ partition ratios) are key to mitigation choices
- To account for super emitters has a strong impact on estimates

Thanks