Importance of energy statistics for estimating GHG emissions

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CO_2 Emissions

Outline

1. International context
2. About CO_2 emissions
3. IEA's CO_2 emissions calculation
4. Data quality
5. Indonesia's CO_2 emissions
6. Conclusions

1. International context

International Context

Stabilization of greenhouse gas concentrations in the atmosphere.

> 1992: United Nations Framework Convention on Climate Change (UNFCCC) at Rio de Janeiro conference

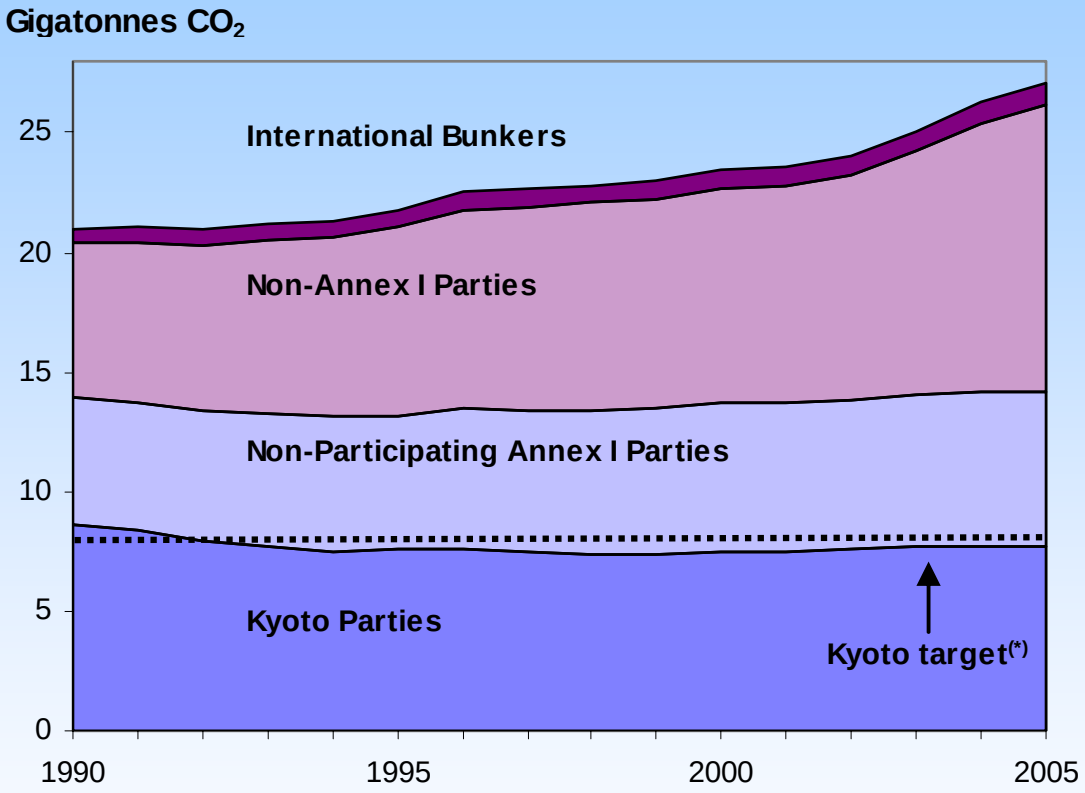
> 1995 (1996): *IPCC Guidelines for National Greenhouse Gas Inventories*
Development of methodologies for gases not controlled by the Montreal Protocol.

> 1997: Kyoto Protocol (entry into force 2005)
Reduction of anthropogenic greenhouse gas emissions for the period 2008-2012 of about 5% compared to 1990.

> 2000: *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*

> 2006: *2006 IPCC Guidelines for National Greenhouse Gas Inventories*

International Context

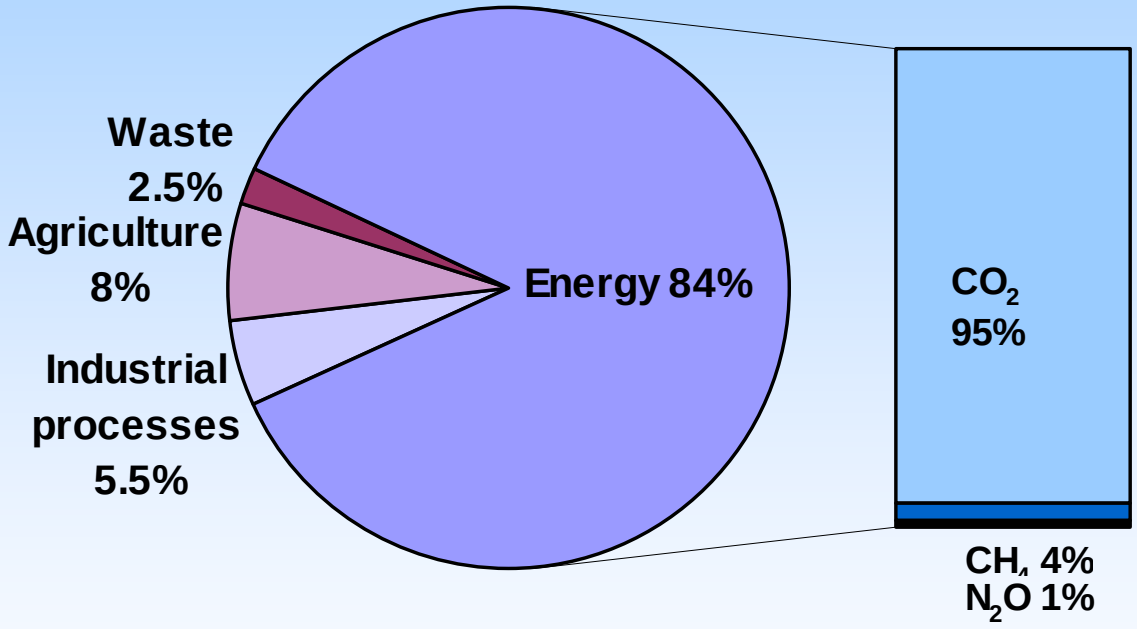


Key point: The Kyoto Protocol is limited in its potential to reduce emissions as not all major emitters are included.

* The target in this graph is based only on CO_2 emission from fuel combustion

2. About CO_2 emissions

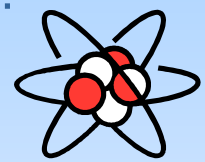
Shares of energy in GHG emissions



Key point: Accounting for the largest share of global GHG emissions, energy is dominated by emissions of CO_2.

How is the CO_2 produced during combustion?

Generic Combustion of Hydrocarbons:



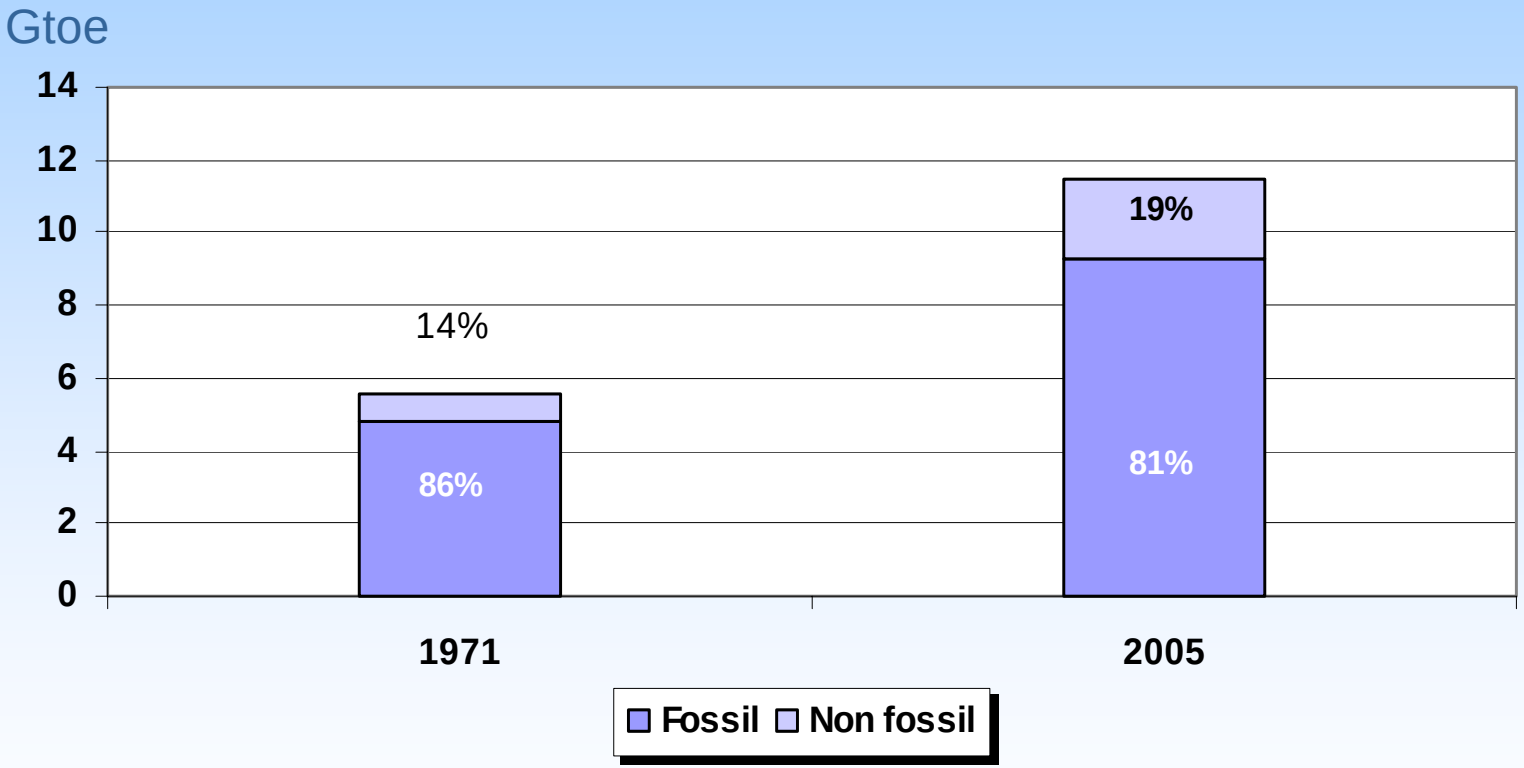
$$C_nH_{2n} + 3n/2\ O_2 \rightarrow n\ CO_2 + n\ H_2O$$

All fossil fuels contain some carbon that produces CO_2 by combining with atmospheric oxygen.

The produced CO_2 accumulates in the atmosphere.

The atmospheric concentration of CO_2 increases.

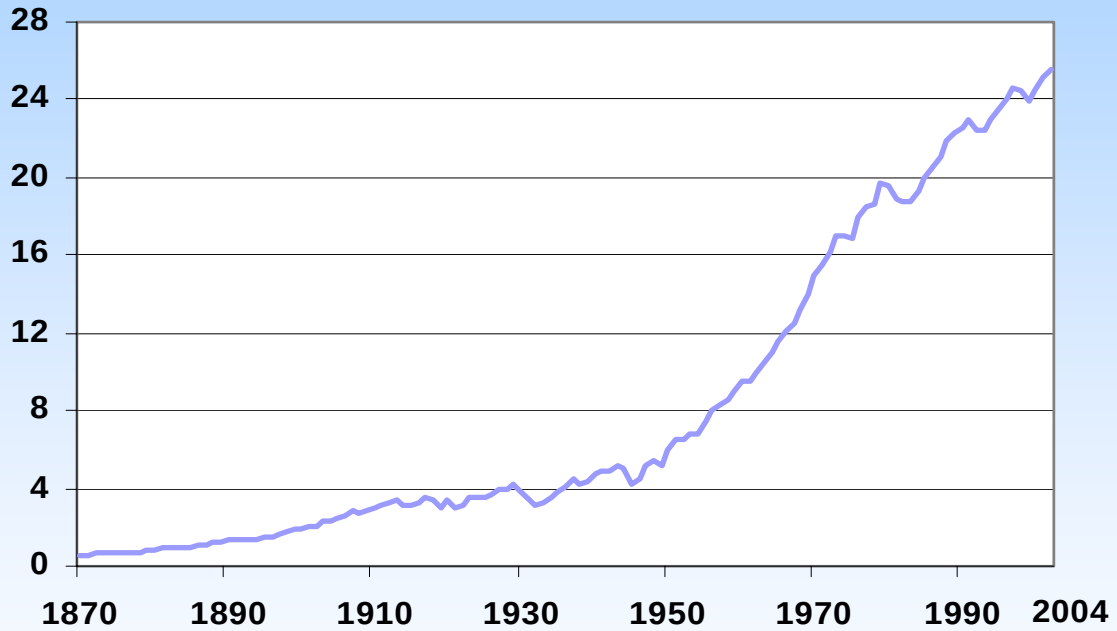
World primary energy supply



Key point: Fossil fuels still satisfy most of the world energy supply.

Trend in CO_2 emissions from fuel combustion

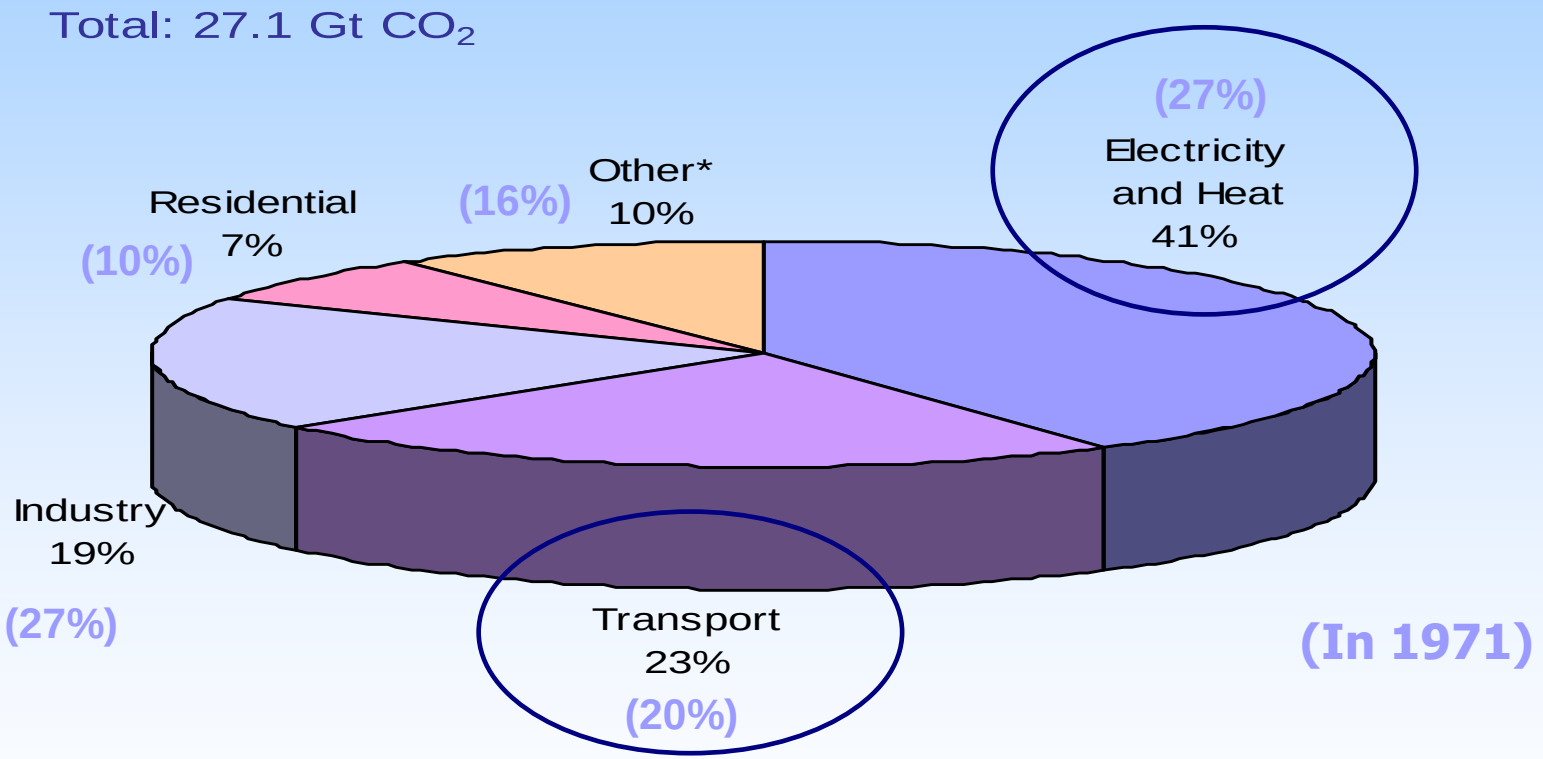
Gigatonnes of CO_2



Source: Oak Ridge National Laboratory

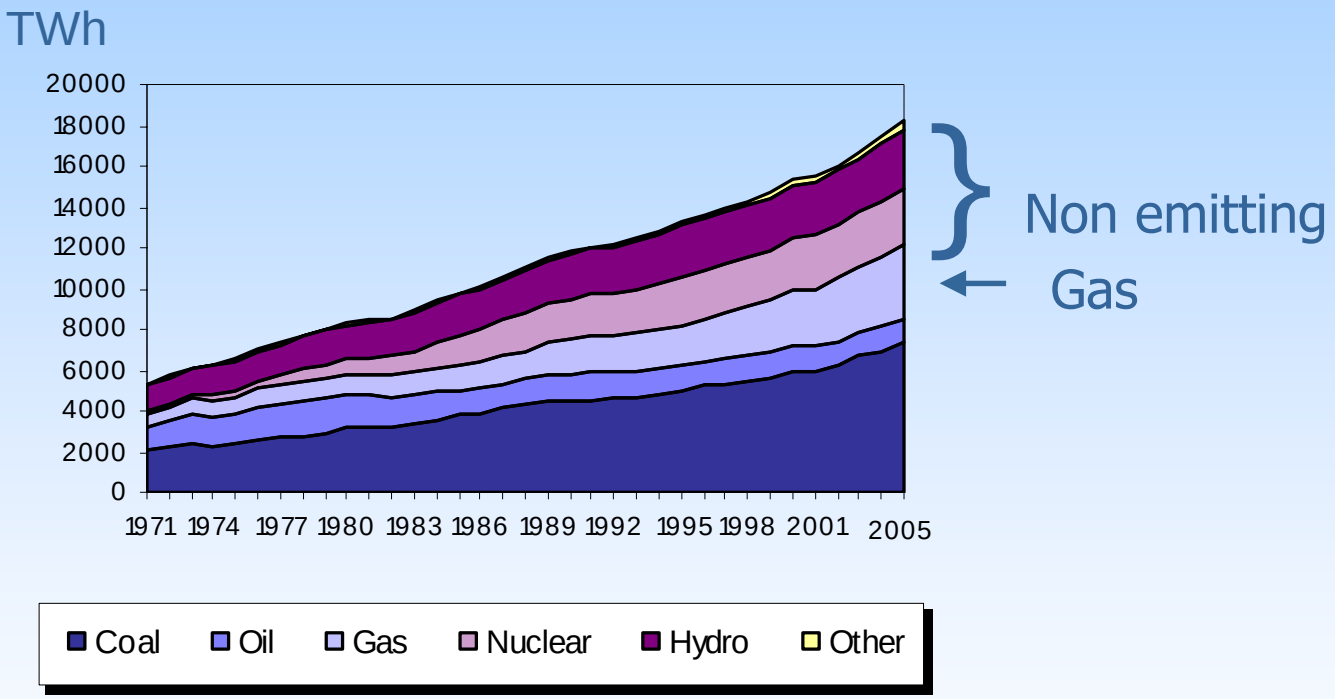
Key point: Since 1870, CO_2 emissions from fuel combustion have risen exponentially.

World CO_2 emissions by sector in 2005



Key point: Between 1971 and 2005, the combined share of electricity and heat generation and transport shifted from 1/2 to 2/3 of global emissions.

World Electricity Generation by Fuel



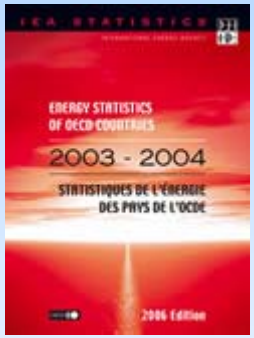
Key point: Although non- and low-emitting sources are growing, electricity generation is becoming more CO_2-intensive as a result of coal use.

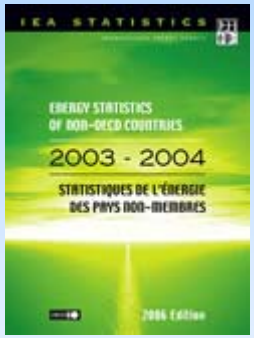
3. IEA's CO_2 emissions calculation

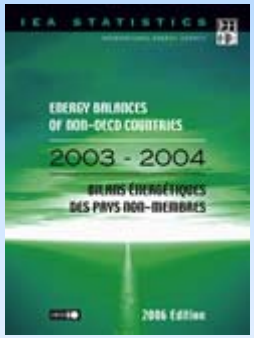
How IEA estimates CO_2 emissions from fuel combustion

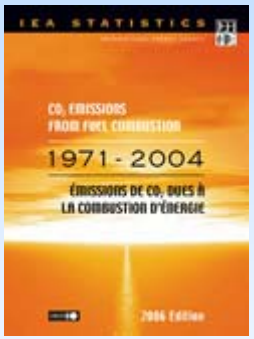
Energy Statistics

Energy Balances









CO_2 Emissions

IPCC Methodologies (Revised 1996)

IPCC Methodologies (Revised 1996)

Basic computation for CO_2 emissions:

- CO_2 emissions by product: Fuel Quantity * Emission Factor (with corrections for stored and unoxidised carbon)
- Sum over all different products

Can be done from two independent sets of data:

Supply of fuels to the country	**Consumption** by end-use sectors
Reference Approach	**Sectoral Approach**

Methodology: Reference Approach

For each product:

Apparent Consumption =

Production
+ Import
- Export
+/- Stock changes
- International bunkers

Primary products only!

Primary and secondary products

* Carbon emission factors

\- Stored Carbon

Primary and secondary products when:

1. not used for combustion (e.g. bitumen);
2. not completely combusted (e.g. lubricants);
3. used as a petrochemical feedstock.

Methodology: Sectoral Approach

For each product:

Consumption =

Energy sector
(electricity production, refineries,…)
+ Industry
+ Transport
+ Services
+ Residential
+ Other final consumption sectors

Primary and secondary products

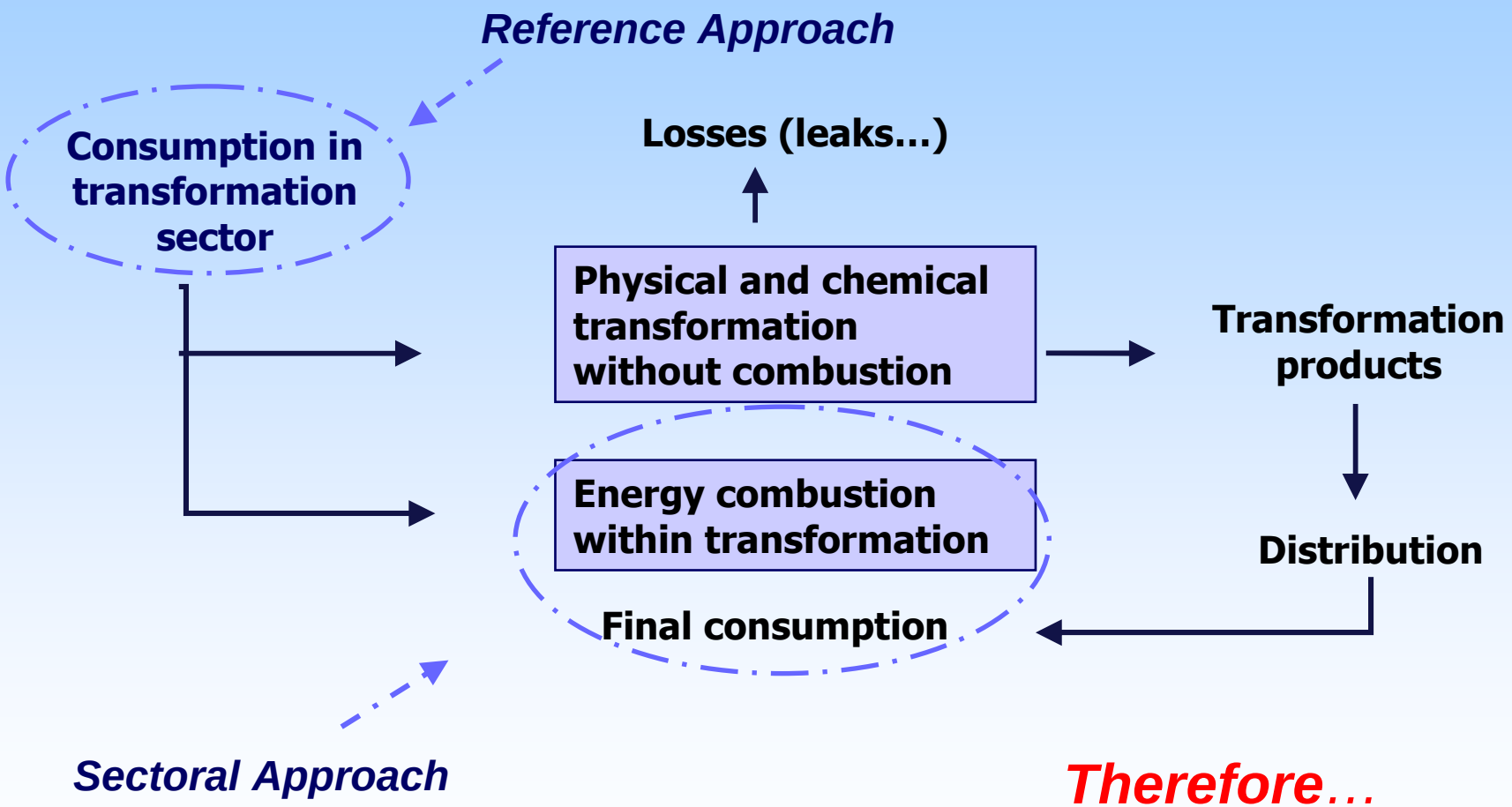
* Carbon emission factors

\- Stored Carbon

Primary and secondary products when:

1. not used for combustion (e.g. bitumen);
2. not completely combusted (e.g. lubricants);
3. used as a petrochemical feedstock.

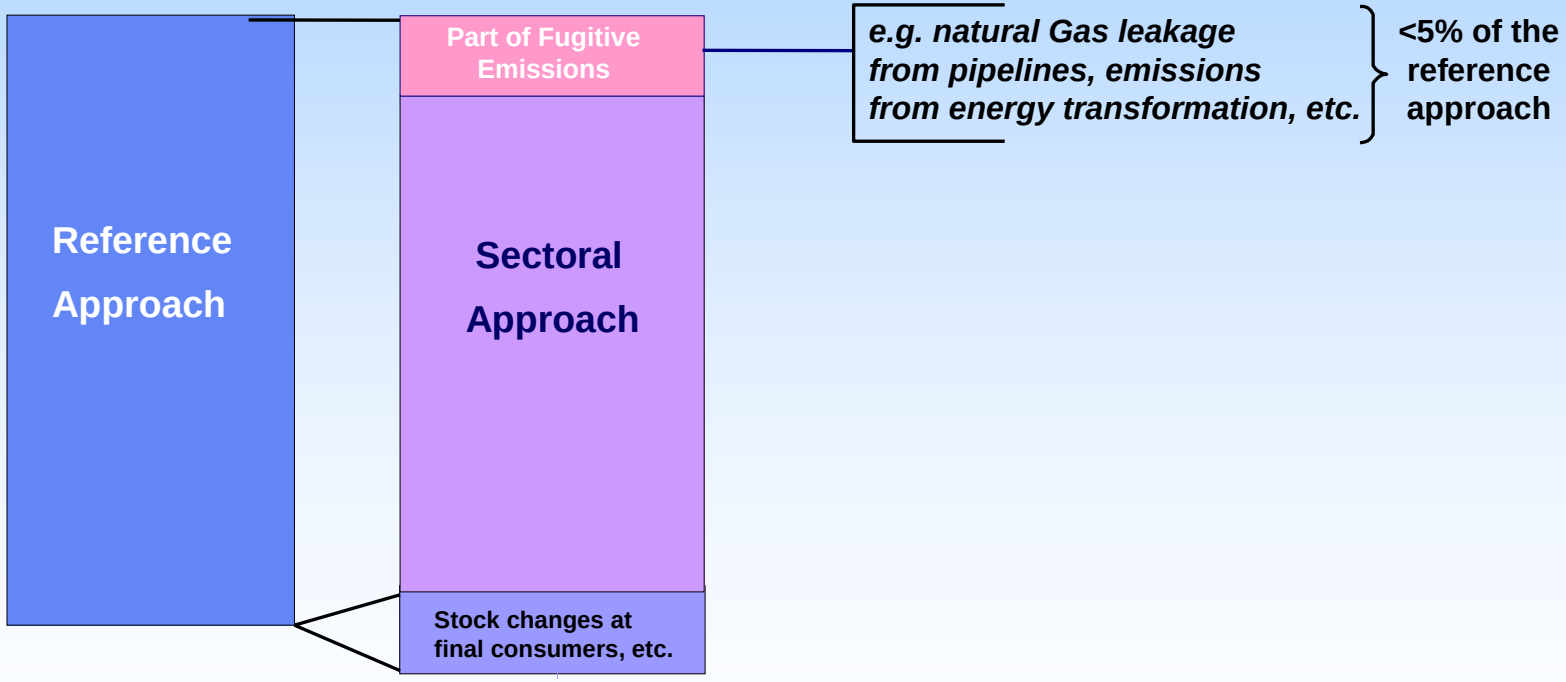
Transformation Sector: Reference vs. Sectoral Approach



Therefore…

Reference vs. Sectoral Approach: CO_2 estimates

Reference Approach is generally an **upper limit** for **Sectoral Approach**



Example of CO_2 emissions computation: Reference Approach (1)

Computing Apparent consumption

Unit	Production A	Imports B	Exports C	International Bunkers D	Stock Change E	Apparent Consumption F=A+B-C-D-E
Primary fuel example						
Crude Oil	Gg	97,835	48,589	68,823	0	-486	78,087
Secondary fuel example						
Gas / Diesel Oil	Gg	0	3,503	5,528	733	27	-2,785

Excluded from national totals

= 97,835 + 48,589 - 68,823 + 486

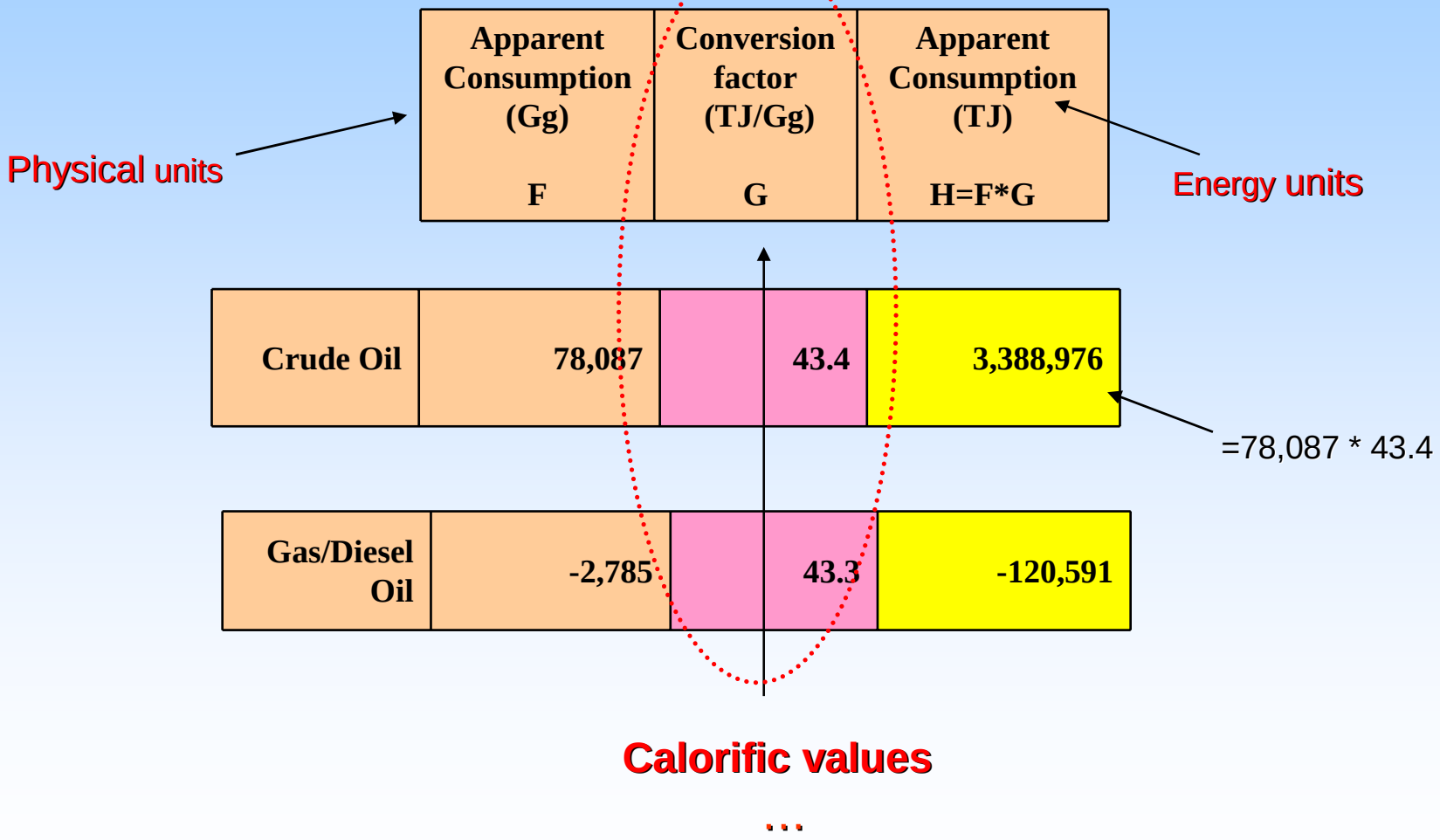
Not all fuels used for bunkers

No production
for secondary fuels!
Already included in apparent consumption of primary fuel

Apparent consumption
can be negative
for a secondary fuel

Example of CO_2 emissions computation: Reference Approach (2)

Computing Apparent consumption



From physical to energy unit: calorific values - some examples

Selected Net Calorific Values *(TJ/10^3 tonnes)*	
Refined Petroleum Products	
Gasoline	44.80
Jet Kerosene	44.59
Other Kerosene	44.75
Shale Oil	36.00
Gas/Diesel Oil	43.33
Residual Fuel Oil	40.19
LPG	47.31
Ethane	47.49
Naphtha	45.01
Bitumen	40.19
Lubricants	40.19
Petroleum Coke	31.00
Refinery Feedstocks	44.80
Refinery Gas	48.15
Other Oil Products	40.19

Caution:
Net vs. Gross
Calorific Values

Revised 1996 IPCC Guidelines contain lists of suggested values.

Example of CO_2 emissions computation: Reference Approach (3)

Computing Carbon Content

Apparent Consumption (TJ)	Carbon emission factor (tC/TJ)	Carbon content (Gg C)
H	I	L=H*I/1000

1 Gg = 1000 t

Carbon emission factors

can be country-specific.

IEA uses default IPCC values.

Crude Oil	3,388,976	20.0	67,780
Gas/Diesel Oil	-120, 590	20.2	-2,436

= 3,390,147 * 20.0 / 1000

Example of CO_2 emissions computation: Reference Approach (4)

Computing CO_2 emissions

	Carbon content (Gg C) J	Carbon Stored (Gg C) K	Net carbon Emissions (Gg C) L=J-K	Fraction of carbon Oxidized M	Actual CO_2 emissions (Gg CO_2) =L*M*44/12
Crude oil	67,780	0	67,780	0.99	246,041
Gas/Diesel Oil	-2,436	126	-2,562	0.99	-9,300

Completeness of the combustion (0.98 to 0.995)

Gas/diesel used as feedstock for non-energy purposes.

From carbon to CO_2 using 44/12 (ratio of the molecular weight of CO_2 / C)

Example of CO_2 emissions computation: Reference Approach (5)

Summing over all fuels

			Actual CO_2 emissions ($Gg\ CO_2$)
Liquid Fossil	Primary Fuels	Crude Oil	246,041
		Orimulsion	0
		Natural Gas Liquids	13,262
	Secondary Fuels	Gasoline	-11,502
		Jet Kerosene	-8,669
		Other Kerosene	-608
		Shale Oil	0
		Gas / Diesel Oil	-9,300
		Residual Fuel Oil	-19,489
		LPG	-2,917
		Ethane	-3,688
		Naphtha	-10,754
		Bitumen	-7,732
		Lubricants	-1,700
		Petroleum Coke	972
		Refinery Feedstocks	9,889
		Other Oil	-2,040
Liquid Fossil Totals			191,765

Example of CO_2 emissions computation: Reference Approach (6)

Summing over all fuels

	Actual CO_2 emissions ($Gg\ CO_2$)
Liquid Fossil Totals (OIL)	**191,765**
Solid Fuel Totals (COAL)	**147,620**
Gaseous Fuel Totals (GAS)	**204,248**
Totals	**543,633**

Example of CO_2 emissions computation: Sectoral Approach (1)

The procedure is similar to that of the Reference Approach,
but it starts from consumption data of end-use sectors

- Iron and Steel
- Chemical and Petrochemical
- Non-Ferrous Metals
- Non-Metallic Minerals
- Transport Equipment
- Machinery
- Mining and Quarrying
- Food and Tobacco
- Paper Pulp and Print
- Wood and Wood Products
- Construction
- Textile and Leather
- Non-specified (Industry)

Example of sub sectors

Manufacturing Industries and Construction

Example of CO_2 emissions computation: Sectoral Approach (2)

IEA final disaggregation in sectors

	World CO_2 emissions 2005 (Mt CO_2)
Total CO_2 Emissions - Sectoral Approach	**27 136**
Main Activity Producer Electricity+Heat Production	9 956
Unallocated Autoproducers of Electricity+CHP+Heat	1 053
Other Energy Industries	1 299
Manufacturing Industries and Construction	5 184
Transport	6 337
Other Sectors	3 308

For comparison:

Total CO_2 Emissions - Reference Approach	**27 632**

2005 World CO_2 Emissions

2005 CO_2 Emissions by Sector

million tonnes of CO_2	Coal	Oil	Gas	Other *	Total	% change 90-05
Sectoral Approach	**10 980.1**	**10 716.7**	**5 346.8**	**92.7**	**27 136.4**	**29.1%**
Main Activity Producer Elec. and Heat	7 400.5	781.5	1 744.1	29.7	9 955.8	43.8%
Unallocated Autoproducers	455.7	172.4	387.9	36.7	1 052.7	79.1%
Other Energy Industries	198.4	651.6	447.6	1.2	1 298.8	29.9%
Manufacturing Industries and Construction	2 464.2	1 487.0	1 210.8	22.0	5 184.0	15.0%
Transport **	16.6	6 154.9	165.4	0.1	6 337.0	37.3%
of which: Road	-	*4 630.1*	*17.8*	-	*4 647.9*	*40.6%*
Other Sectors	444.6	1 469.4	1 391.0	3.0	3 308.1	-2.5%
of which: Residential	*274.6*	*677.6*	*936.4*	*0.0*	*1 888.6*	*3.5%*
Reference Approach	**11 255.9**	**10 863.9**	**5 419.7**	**92.7**	**27 632.3**	**28.5%**
Diff. due to Losses and/or Transformation	239.8	82.5	81.1	0.0	403.3	
Statistical Differences	36.0	64.7	- 8.2	- 0.0	92.6	
Memo: International Marine Bunkers **	-	*543.4*	-	-	*543.4*	*51.9%*
Memo: International Aviation **	-	*415.6*	-	-	*415.6*	*42.5%*

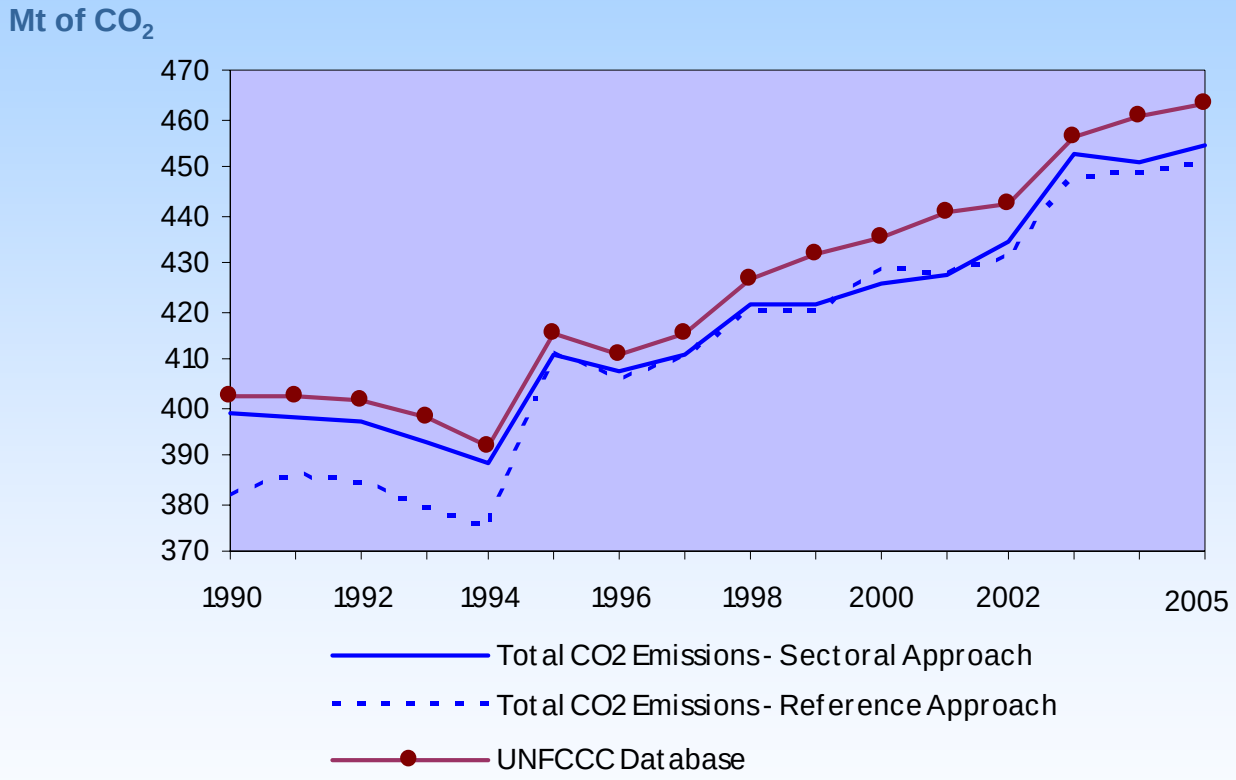
* Other includes industrial waste and non-renewable municipal waste.

** World includes international marine bunkers and international aviation.

4. Data quality

Italy

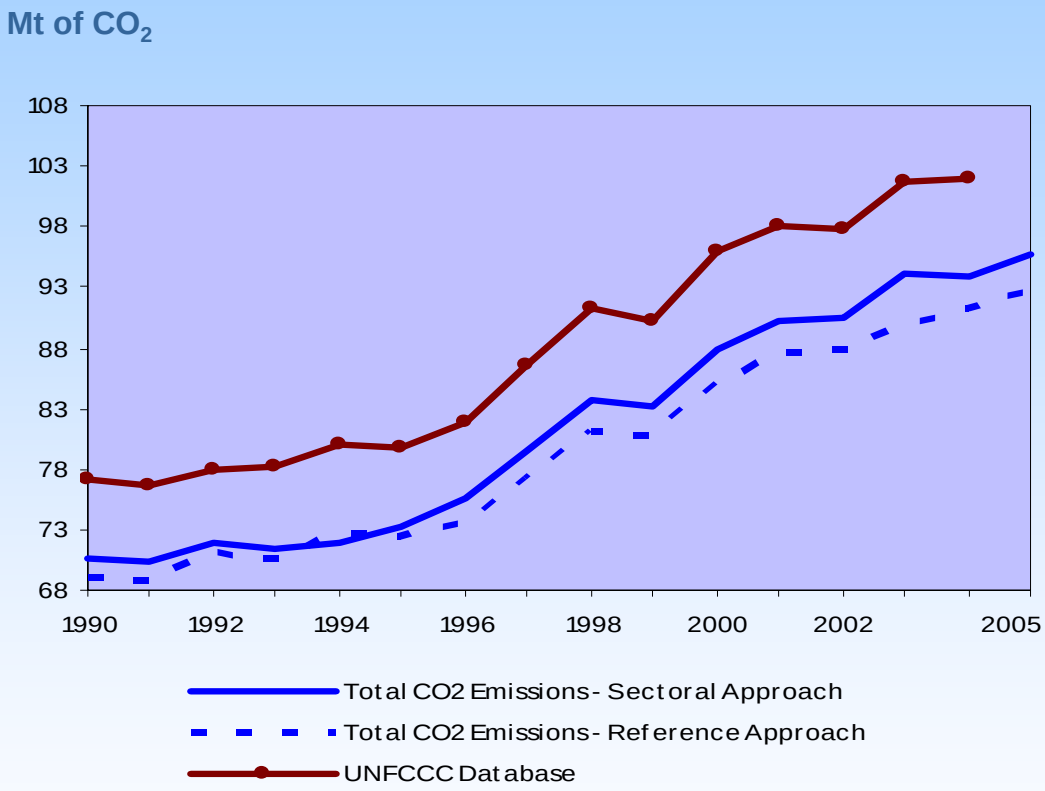
Reference vs Sectoral Approach



Key point: Data quality is improving over time.

Greece

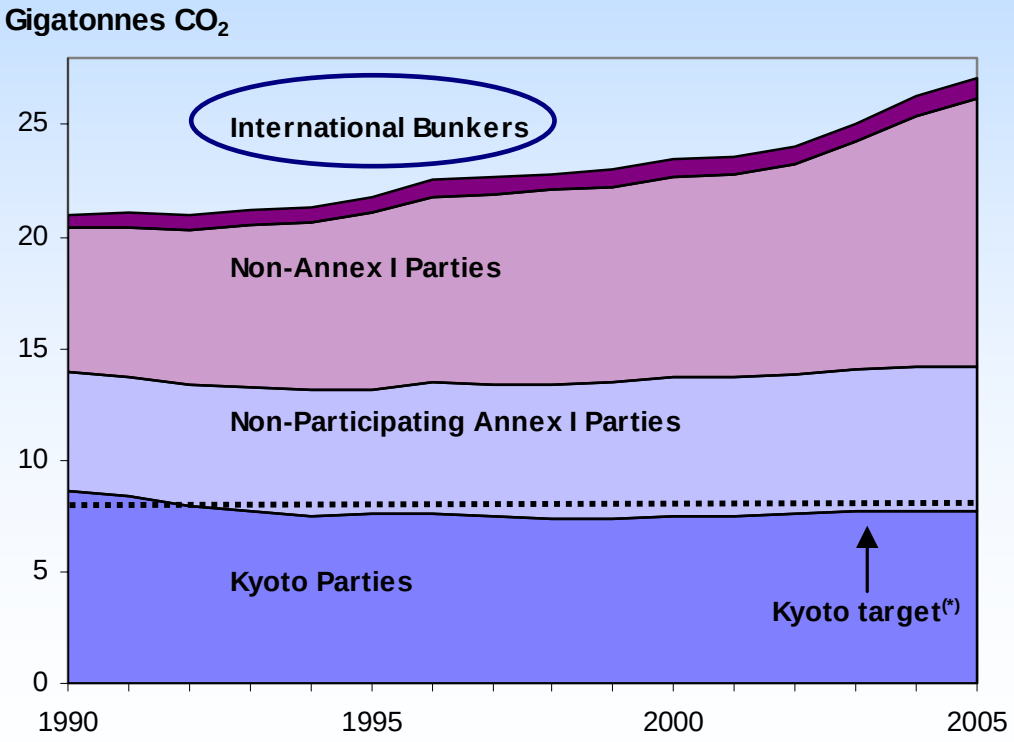
Reference vs Sectoral Approach



Key point: It is not unusual to have level differences between the IEA estimates and the UNFCCC numbers – trends should be the same.

Note on International Bunkers

***IPCC Guidelines*:** International aviation and international marine bunkers are not included in national totals.



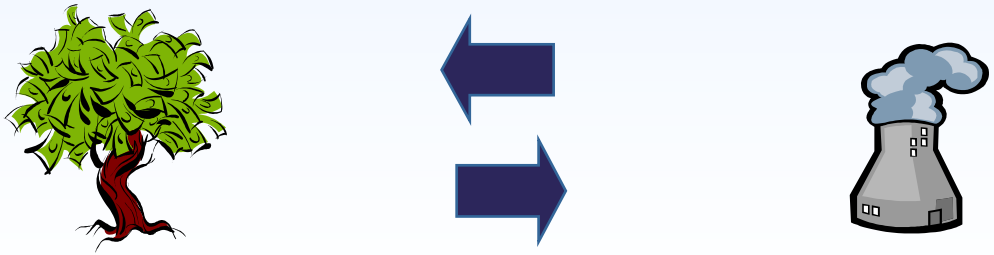
Note on Biomass

***IPCC Guidelines*:** Biomass is not included in national totals for CO_2 emissions from fuel combustion.

Biomass contains carbon, absorbed by plants through photosynthesis.

However, if biomass is sustainably grown, no additional CO_2 is considered as emitted into the atmosphere.

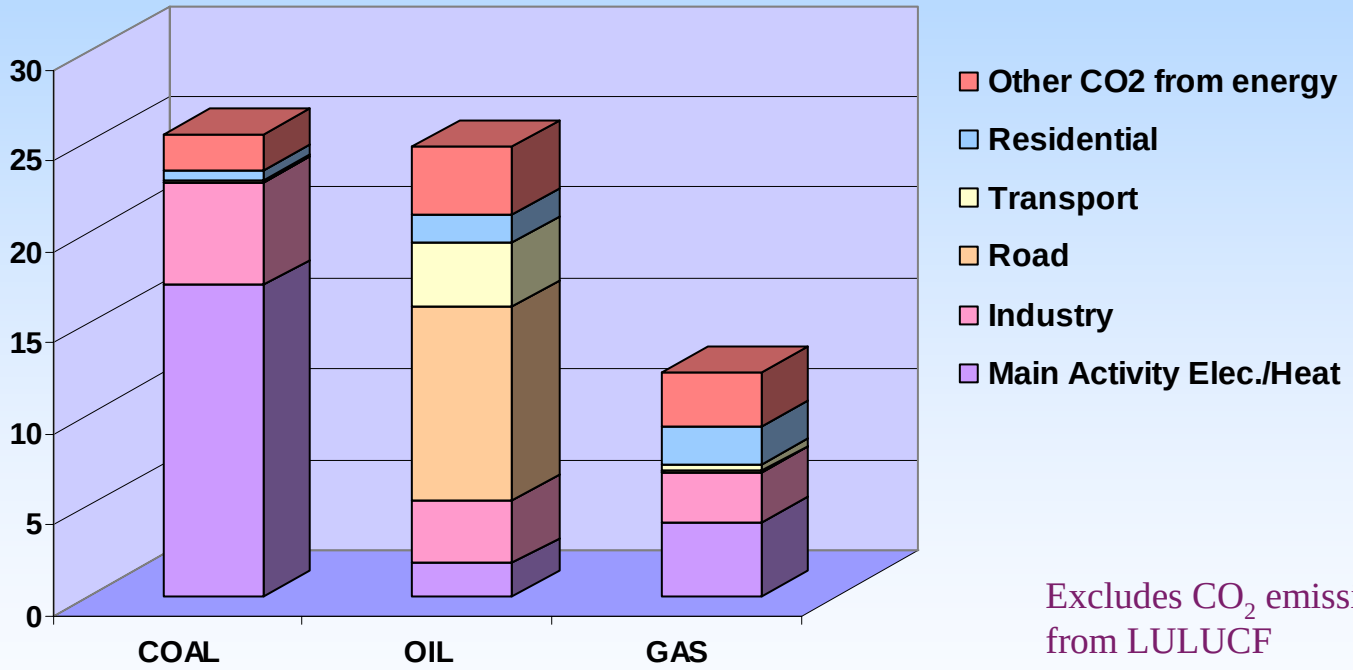
If there is a change in the biomass stocks, then the CO_2 is accounted for in LULUCF.



Key Sources for CO_2 Emissions from Fuel Combustion

World 2005

Level Assessment (%)



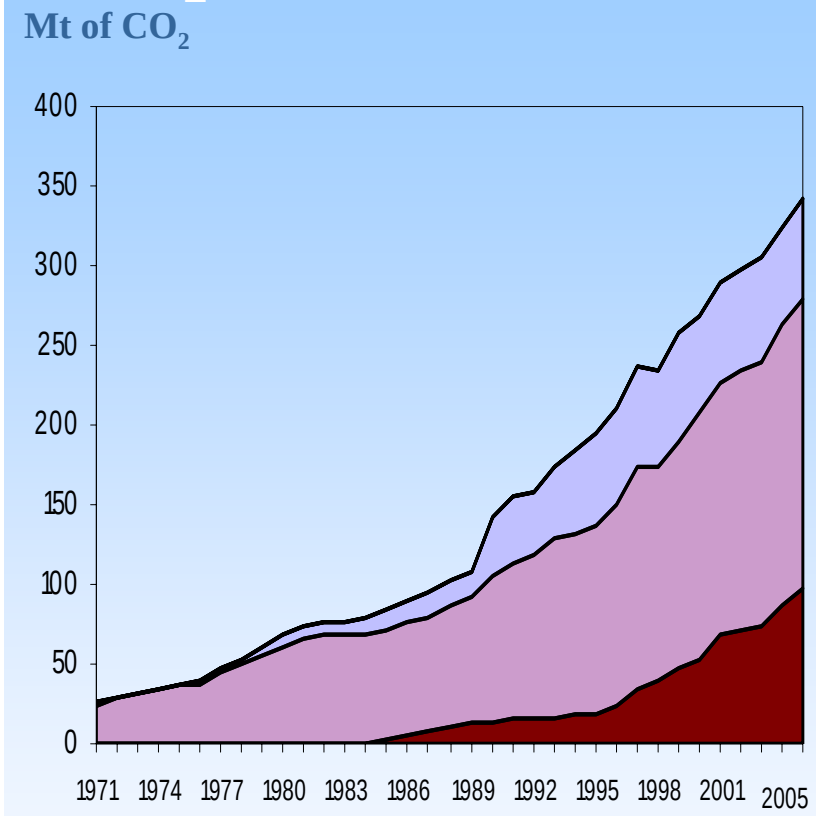
Excludes CO_2 emissions/removals from LULUCF

Key point: Key source analysis can help identify which sectors would benefit from better quality data, NCVs and emission factors.

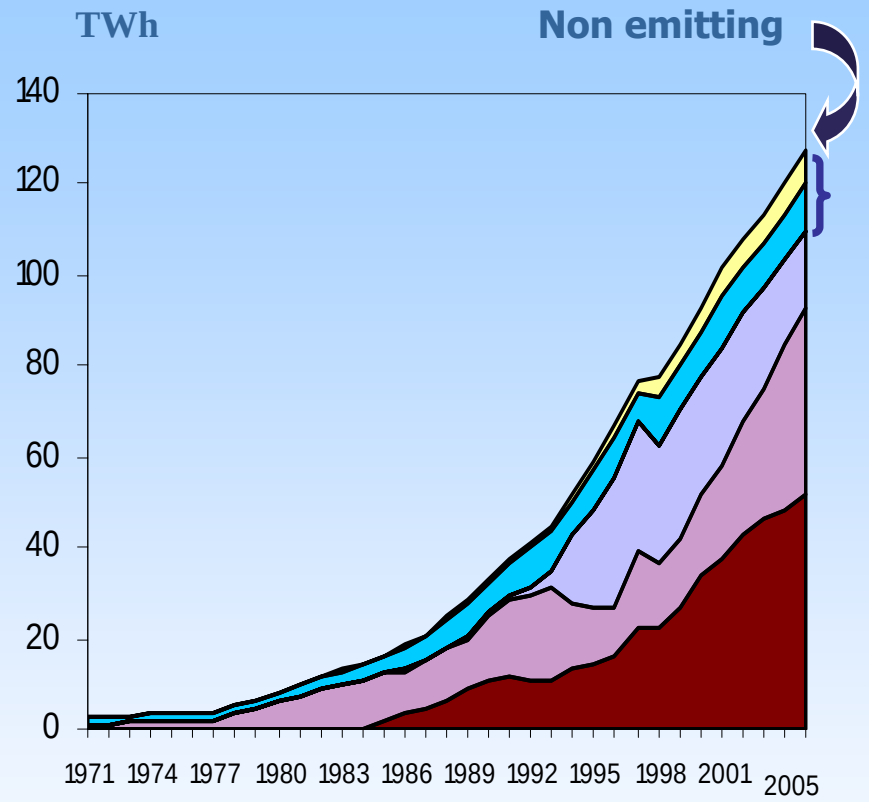
5. Indonesia's CO_2 emissions

Indonesia

CO_2 Emission by Fuel



Electricity generation by fuel



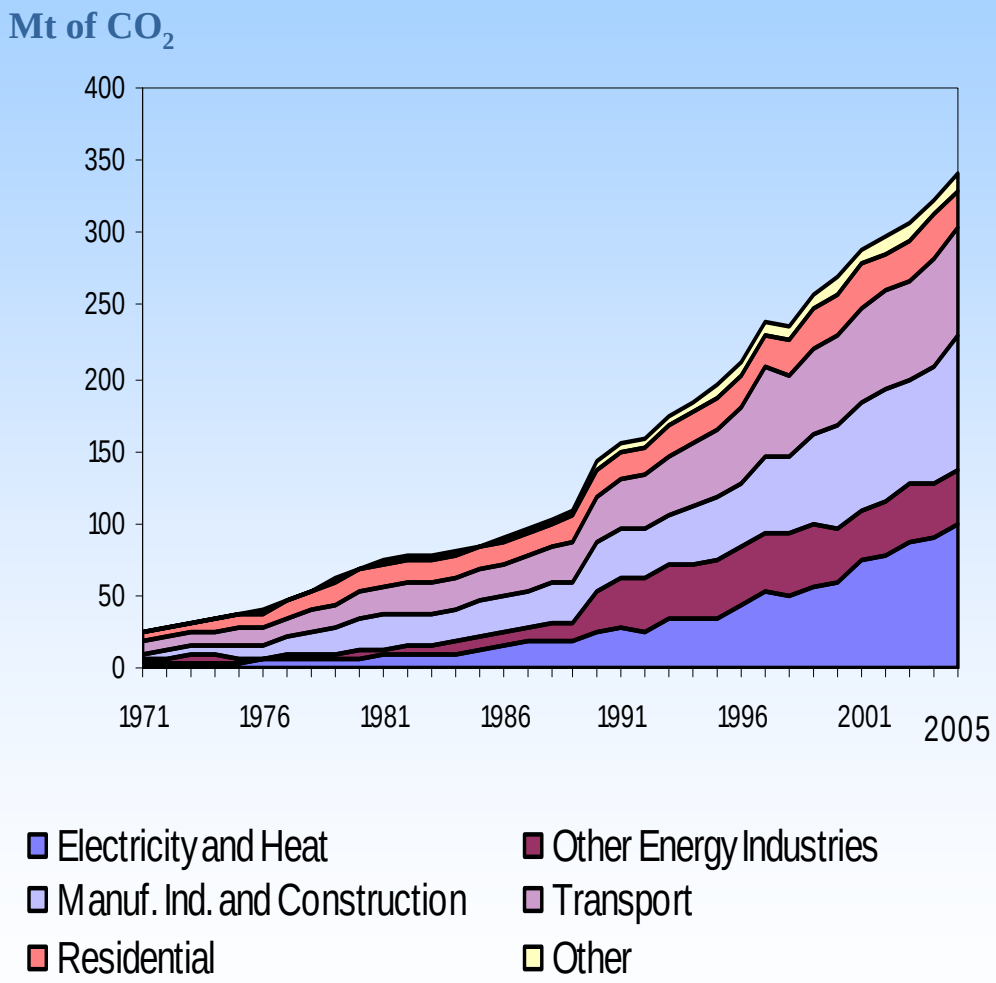
- Between 1990 and 2005, CO2 emissions increased by 141%
- In 2005, oil contributed 53%, coal 29% and gas 18% of CO2 emissions from fuel combustion

- 41% of the electricity generation in 2005 was made from Coal.
- The non emitting sources represented 14% of the total electricity generation in 2005.

IEA estimates

Indonesia

CO_2 Emissions by Sector

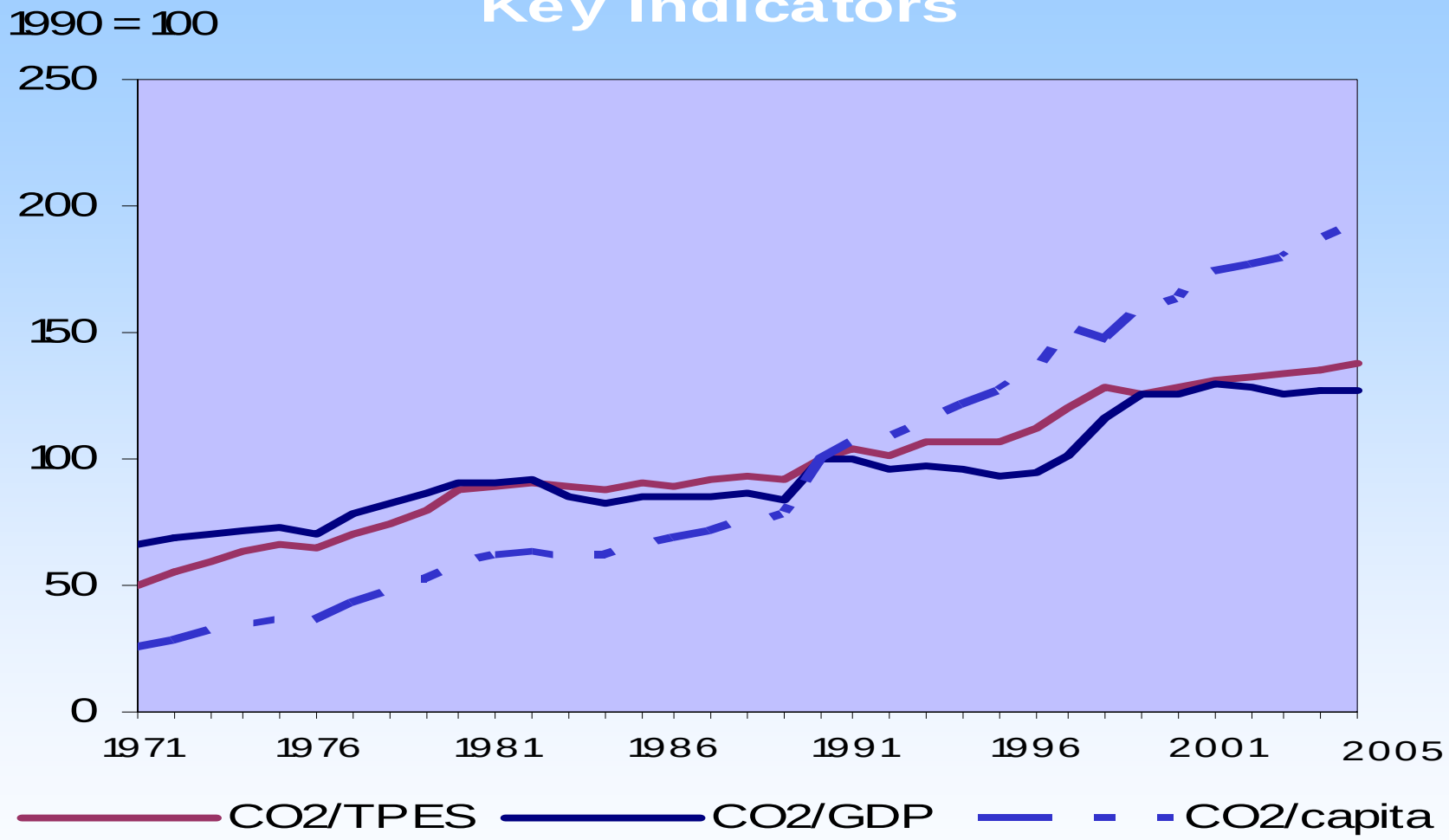


- **Main activity electricity/heat was the largest source (28%).**
  industry: 27%
  road: 20%
  residential: 8%
- **The share of Main Activity Electricity/Heat more than double since 1971.**

IEA estimates

Indonesia

Key Indicators



IEA estimates

6. Conclusions

Importance of energy statistics for estimating GHG emissions

- **Fossil fuel combustion is the single largest human influence on climate.**
- **Two sectors, both growing rapidly, represent the bulk of CO_2 emissions from fuel:**
  electricity and heat generation
  transport
- **Effective emissions mitigation will require all countries, regardless of energy demand and infrastructure, to use energy in a sustainable manner.**
- **Up-to-date and accurate information on energy use and GHG emissions is essential for countries to monitor their progress in reducing GHG emissions as well as to verify and validate the Kyoto targets.**

Thank you very much

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