

Climate MRV for Africa – Phase 2 Development of National GHG Inventory ENERGY – Stationary Combustion



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Lead partner

GreenStream

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Precisely Right.

camco
clean energy

Project of the European Commission DG Climate Action

EuropeAid/136245/DH/SER/MULTI

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Team Leader and Key Experts

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Energy: Fuel combustion

➤ 5 main source categories:

Energy industry

Manufacturing

Transport

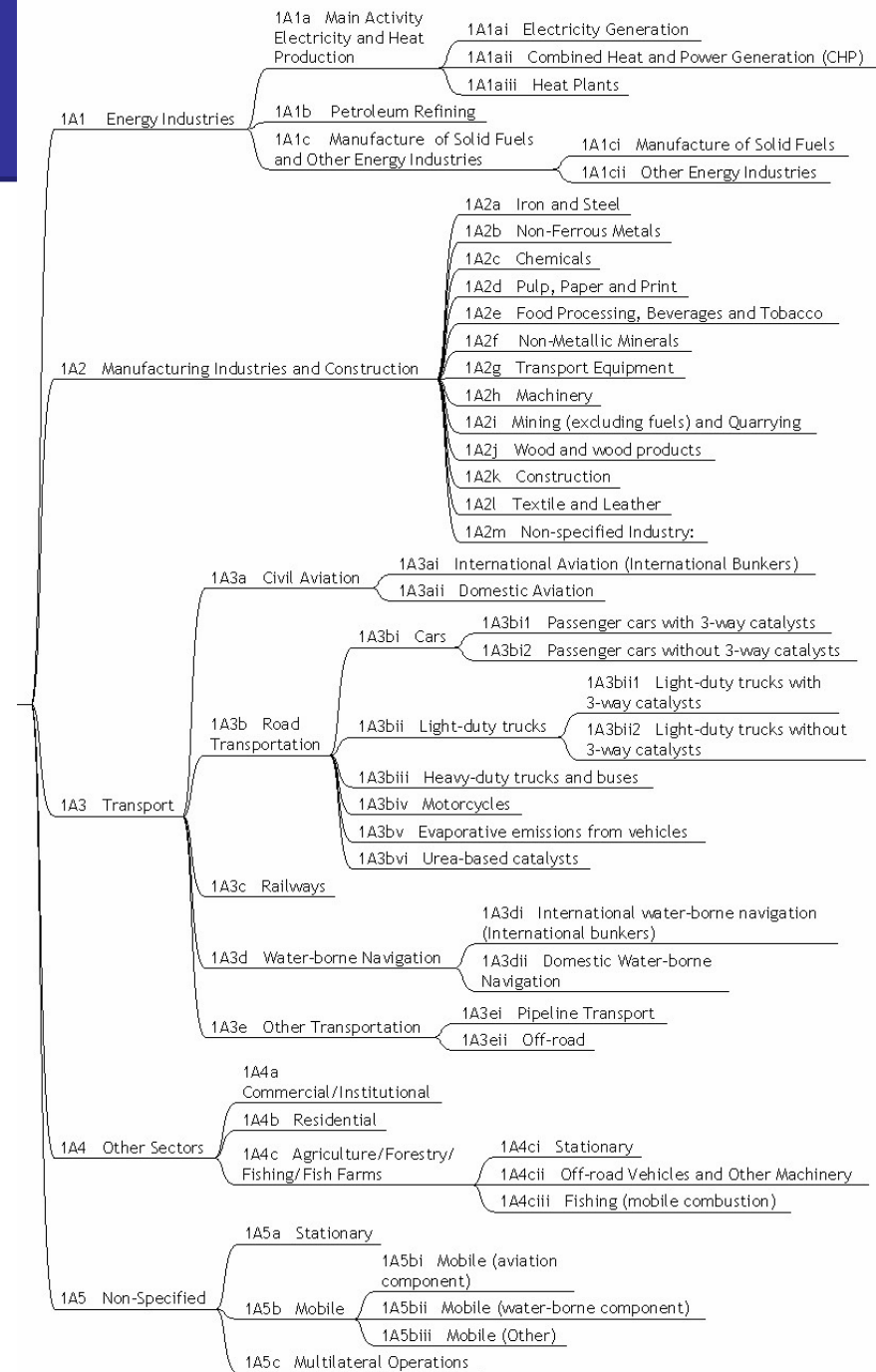
Other sectors

Non-Specified

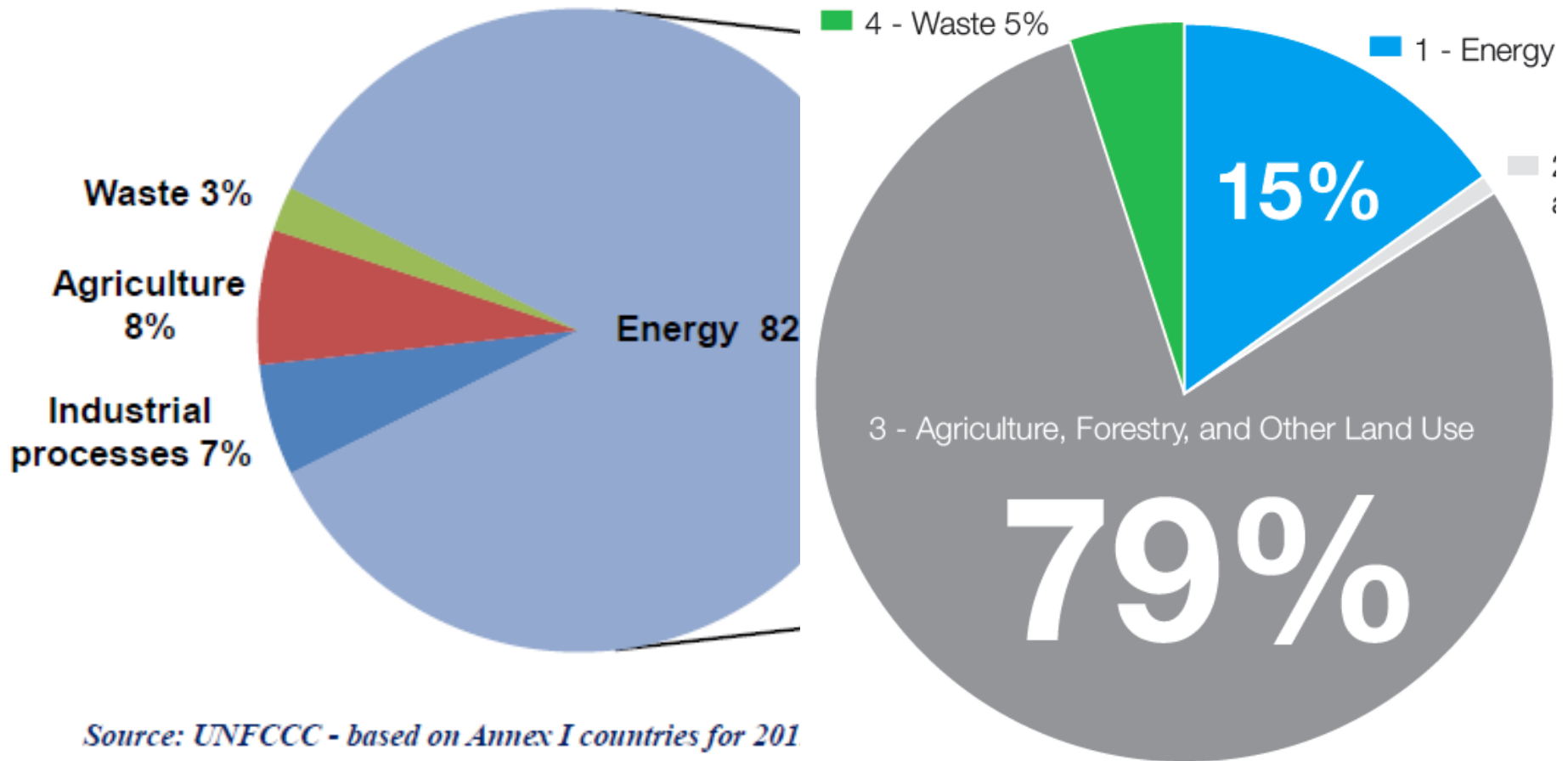
➤ 2 combustion types:

Stationary

Mobile

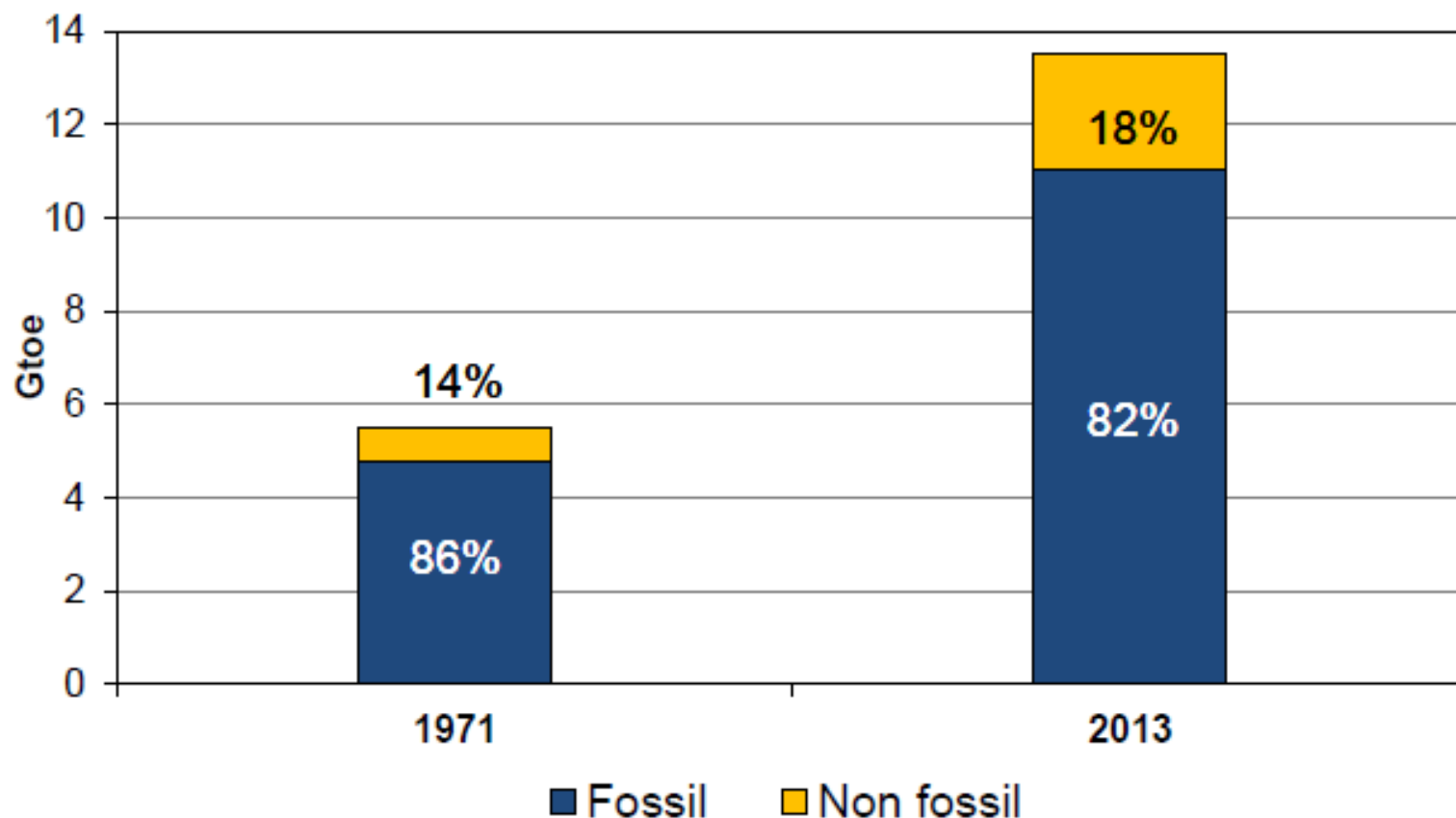


Energy in the overall GHG matrix



- Energy sector emissions (which are predominantly CO₂) account for the largest share of global GHG emission

Energy in the overall GHG matrix



- Despite growth in renewable energy, fossil fuels still meet the bulk of the world's energy needs

IPCC Methodology - Overview

- Two sets of IPCC Guidelines apply:
 - Revised 1996 IPCC Guidelines*
 - 2006 IPCC Guidelines*
- The first Kyoto Protocol commitment period (2008-2012) was based on the *Revised 1996 IPCC Guidelines*. Annex-I countries were estimating CO₂ using these guidelines
- In 2015, Annex-I countries started reporting to the UNFCCC using the *2006 IPCC Guidelines*

IPCC Methodology - Overview

Tier 1

- Simplest method
- Activity data available for all countries

Tier 2

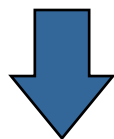
- Country/Technology-specific emission factors

Tier 3

- More detailed or country-specific methods



Tier 1: Can be done from two independent sets of data:



Reference Approach
Supply of fuels to the country

Sectoral Approach
Consumption by end-use sectors

IPCC Methodology – Data

Activity data

- Energy statistics and balances (national)
- Amount of fuels consumed/combusted

Fuel definitions (IEA list)

- Country/Technology-specific emission factors

Conversion of energy units

- More detailed or country-specific methods

Calorific values (gross & net) (UNFCCC/EFDB/IEA)

- Default vs. Country-specific

Emission factors (carbon content) (UNFCCC/EFDB)

- Default vs. Country-specific

IPCC Methodology – Uncertainty

➤ Activity data uncertainty

- Depends on activity: sector and sub-sector
- Default IPCC: $\pm 5\%$

➤ Emission factor uncertainty

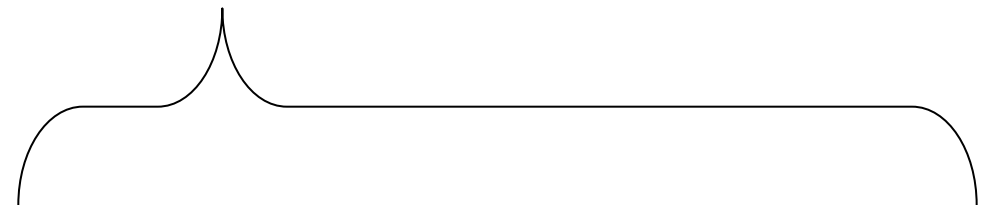
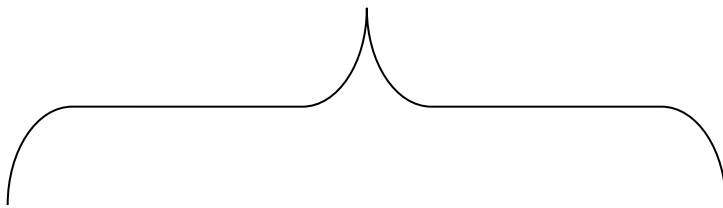
- Different for CO₂ , CH₄ , N₂O
- CO₂: low uncertainty, typically $\pm 5\%$
- CH₄ & N₂O: high uncertainty up to $\pm 300\%$!!!



IPCC Methodology - Overview

➤ Fundamental equation

A			B			= A x B
Fuel consumption	(TJ)	x	Emissions factor	(kg CO₂/TJ)	=	CO₂ emissions
						(kg CO₂)



A1		A2
Fuel consumption	x	Net calorific value
(unit)		(TJ/unit)

B1		B2		B3
Carbon emissions factor	x	Fraction of carbon oxidized	x	Molar ratio
(kgC/TJ)		(%)		(44/12)

IPCC Methodology – Reference approach

Step 1: Estimating apparent fuel consumption

Sector		ENERGY					
Category		Fuel combustion activities (1A)					
Sheet		CO ₂ from energy sources - Reference Approach					
		STEP 1					
		A	B	C	D	E	F
		Production	Imports	Exports	International Bunkers	Stock Change	Apparent Consumption F=A+B-C-D-E
Primary	Crude Oil						
Fuels	Orimulsion						
	Natural Gas Liquids						
Secondary	Gasoline						
Fuels	Jet Kerosene						
	Other Kerosene						
	Shale Oil						
	Gas / Diesel Oil						
	Residual Fuel Oil						
	LPG						
	Ethane						
	Naphtha						
	Bitumen						
	Lubricants						

Units:
Mass units (e.g. tonnes) but converted to Gg (giga grams)

Primary/Secondary Fuels:
Avoid double-counting

International Bunkers:
To be excluded from the calculation

IPCC Methodology - Reference approach

Step 2: Converting to a common energy unit

Sector		ENERGY				
Category		Fuel combustion activities (1A)				
Sheet		CO ₂ from energy sources - Reference Approach				
		STEP 1	STEP 2		STEP 3	
		F	G	H	I	J
		Apparent Consumption (Gg)	Conversion Factor (TJ/Gg)	Apparent Consumption (TJ)	Carbon Content (t C/TJ)	Total Carbon (Gg C)
				$H=F \cdot G$		$J=H \cdot I / 1000$
Primary	Crude Oil					
Fuels	Orimulsion					
	Natural Gas Liquids					
Secondary	Gasoline					
Fuels	Jet Kerosene					
	Other Kerosene					
	Shale Oil					
	Gas / Diesel Oil					
	Residual Fuel Oil					
	LPG					
	Ethane					
	Naphtha					
	Bitumen					
	Lubricants					

Default NCV factors given in
Table 1.2

Some country-specific NCVs
available from UNFCCC (EFDB)

IPCC Methodology - Reference approach

Step 3: Multiplying by carbon emission factors

Sector		ENERGY		
Category		Fuel combustion activities (1A)		
Sub-category		CO ₂ from energy sources - Reference Approach		
		CARBON EMISSION FACTORS (CEF)		STEP 3
Fuel		Carbon Content (kg C/GJ)	H Apparent consumption (TJ)	I Carbon Content (t C/TJ)
			H=F*G	J Total Carbon (Gg C)
				J=H*I/1000
		LIQUID FOSSIL		
		<i>Primary fuels</i>		
	Crude oil	20.0		
	Orimulsion	22.0		
Primary	Crude Oil			
Fuels	Orimulsion			
	Natural Gas Liquids	17.5		
		<i>Secondary fuels/products</i>		
	Gasoline	18.9		
	Jet kerosene	19.5		
Secondary	Gasoline			
Fuels	Jet Kerosene			
	Other kerosene	19.6		
	Shale oil	20.0		
	Other Kerosene	20.2		
	Shale Oil	21.1		
	Gas / Diesel Oil	17.2		
	Residual Fuel Oil	16.8		
	LPG	20.0		
	Ethane	22.0		
	Naphtha	20.0		
	LPG	20.0		
	Ethane	26.6		
	Naphtha	20.0		
	Bitumen	15.7		
	Lubricants	20.0		
	Petroleum coke	20.0		
	Refinery feedstocks	20.0		
	Refinery gas	15.7		
	Other oil	20.0		

Carbon Content::
kg C/GJ = t C/TJ

Table 1.4

IPCC Methodology - Reference approach

Step 4: Calculating excluded carbon (stored)

Sector		ENERGY				
Category		Fuel combustion activities (1A)				
Sheet		CO ₂ from energy sources - Reference Approach				
		STEP 3	STEP 4		STEP 5	
		J	K	L	M	N
		Total Carbon (Gg C)	Excluded Carbon (Gg C)	Net Carbon Emissions (Gg C)	Fraction of Carbon Oxidised	Actual CO ₂ Emissions (Gg CO ₂)
				$L=J-K$		$N=L*M*44/12$
Primary	Crude Oil					
Fuels	Orimulsion					
	Natural Gas Liquids					
Secondary	Gasoline					
Fuels	Jet Kerosene					
	Other Kerosene					
	Shale Oil					
	Gas / Diesel Oil					
	Residual Fuel Oil					
	LPG					
	Ethane					
	Naphtha					
	Bitumen					
	Lubricants					

- Feedstocks
- Reductants
- Non-energy use

Often applies to:

- Naphta
- Bitumen
- Coke Oven Coke
- Natural Gas

IPCC Methodology - Reference approach

Step 5: Correcting for carbon unoxidised

Sector		ENERGY				
Category		Fuel combustion activities (1A)				
Sheet		CO ₂ from energy sources - Reference Approach				
		STEP 3	STEP 4		STEP 5	
		J	K	L	M	N
		Total Carbon (Gg C)	Excluded Carbon (Gg C)	Net Carbon Emissions (Gg C)	Fraction of Carbon Oxidised	Actual CO ₂ Emissions (Gg CO ₂)
				L=J-K		N=L*M*44/12
Primary Fuels	Crude Oil					
	Orimulsion					
	Natural Gas Liquids					
Secondary Fuels	Gasoline					
	Jet Kerosene					
	Other Kerosene					
	Shale Oil					
	Gas / Diesel Oil					
	Residual Fuel Oil					
	LPG					
	Ethane					
	Naphtha					
	Bitumen					
Lubricants						

Oxidation
2006 Guidelines: all 100% (= 1)

Convert carbon (C) to CO₂ :
multiply by 44/12

IPCC Methodology - Detail

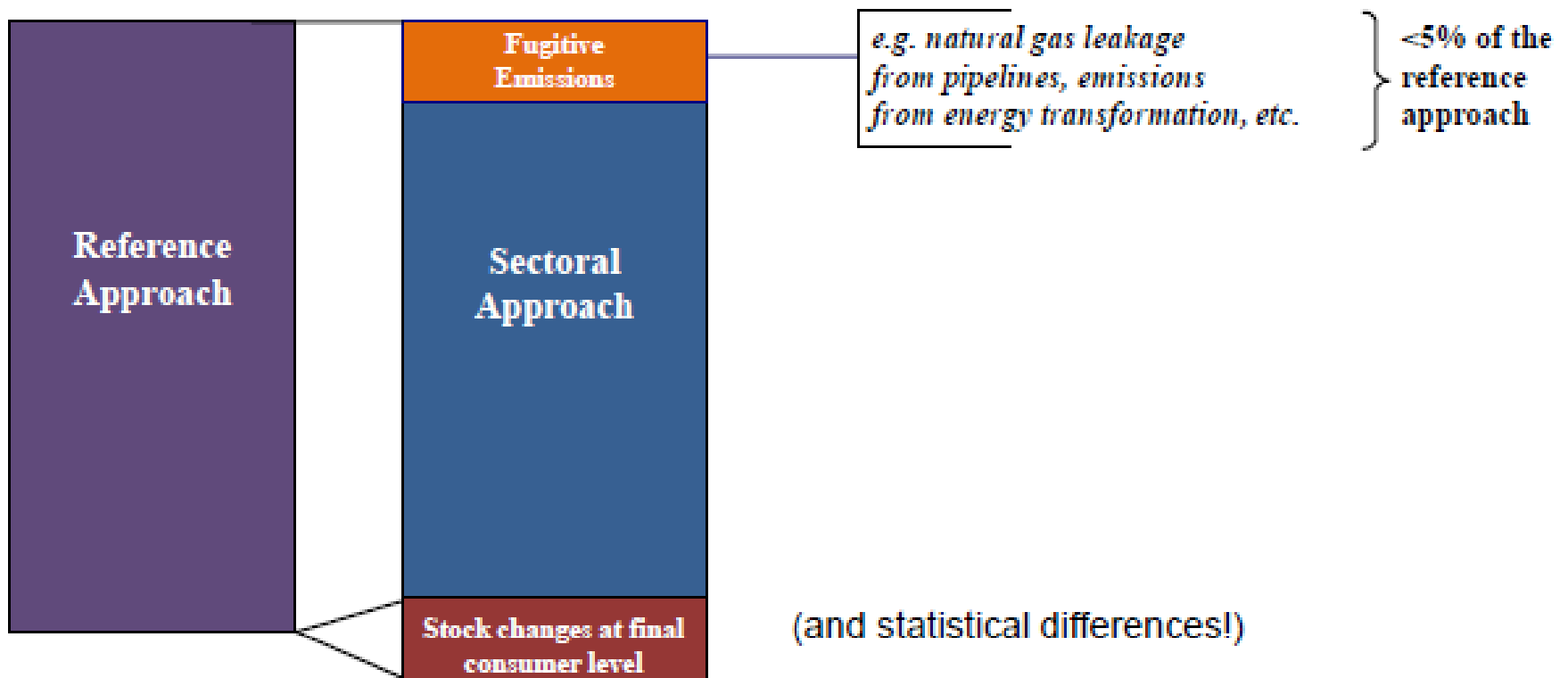
➤ Sectoral approach

Repeat Steps 1 to 5 for each of the main sectors (key source categories):



Data quality: Reference vs. Sectoral approach

- Reference approach sets an upper limit for Sectoral approach



- Comparing the Reference approach with the Sectoral approach is one way to control data quality.

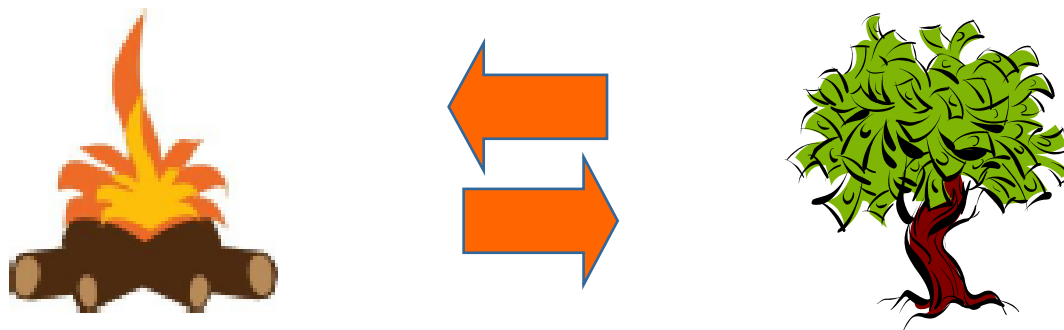
IPCC Methodology – remarks (1)

- **Biomass is not included** in national totals for CO₂ emissions from fuel combustion

(but is included for CH₄ & N₂O !!!)

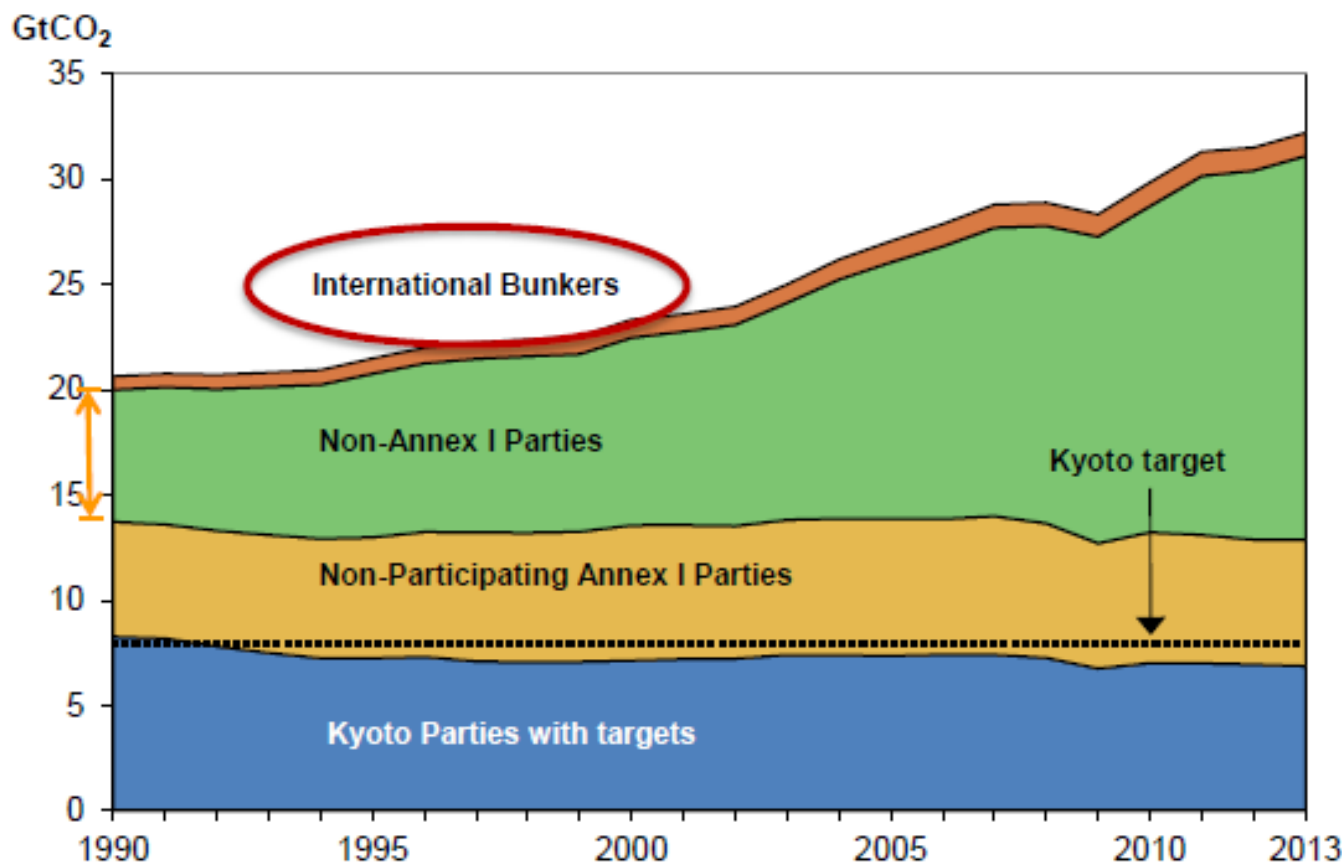
The CO₂ released in the atmosphere during the combustion of biomass is re-absorbed as trees and plants grow. Therefore, if biomass is burnt sustainably, **no additional** CO₂ is emitted.

If there is a net change in the biomass stocks, then the CO₂ is accounted for in AFOLU source category



IPCC Methodology – remarks (2)

- **International bunkers:** international aviation and international marine bunkers are **not included** in national GHG inventories



Thank you!

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