

Climate MRV for Africa – Phase 2 Development of National GHG Inventory Energy – Fugitive Gas Emissions



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Project of the European Commission DG Climate Action

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Team Leader and Key Experts

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Fundamentals

➤ Categories in 2006 IPCC guidelines

B. Fugitive emissions from fuels

1. Solid fuels
2. Oil and Natural Gas

➤ Fugitive gas emissions occur **at all stages** of the production and distribution of fuels:

- ❑ **Coal** is pre-mined, mined, transported & when mines are abandoned
- ❑ **Oil & Natural Gas** are explored, produced, transported, distributed



Fugitive Emissions from Solid Fuels (Coal)

Fugitive Emissions from Coal

➤ Two Types of Coal Mining

- ❑ Open cast (photo)
- ❑ Underground (shaft mining)



➤ In both cases, GHG gases (CO₂, CH₄, N₂O, CO, etc.) are released during:

- ❑ Pre-mining – gas venting to ensure mine safety
- ❑ Venting – degasification during mining
- ❑ Handling & transporting (low temperature oxidation)
- ❑ Abandoning – leaving mine after useful life
- ❑ Uncontrolled combustion (spontaneous combustion of coal)

Fugitive Emissions from Coal

➤ Different Types of Coal Mine Gases

- ❑ **CBM – coal bed methane** (also known as CSM – coal seam methane) – methane found in coal beds/seams
- ❑ **CMM – coal mine methane** (also known as WMM/working mine methane) – emitted when coal mines are worked
- ❑ **AMM – abandoned mine methane**, emitted after a mine has been abandoned.

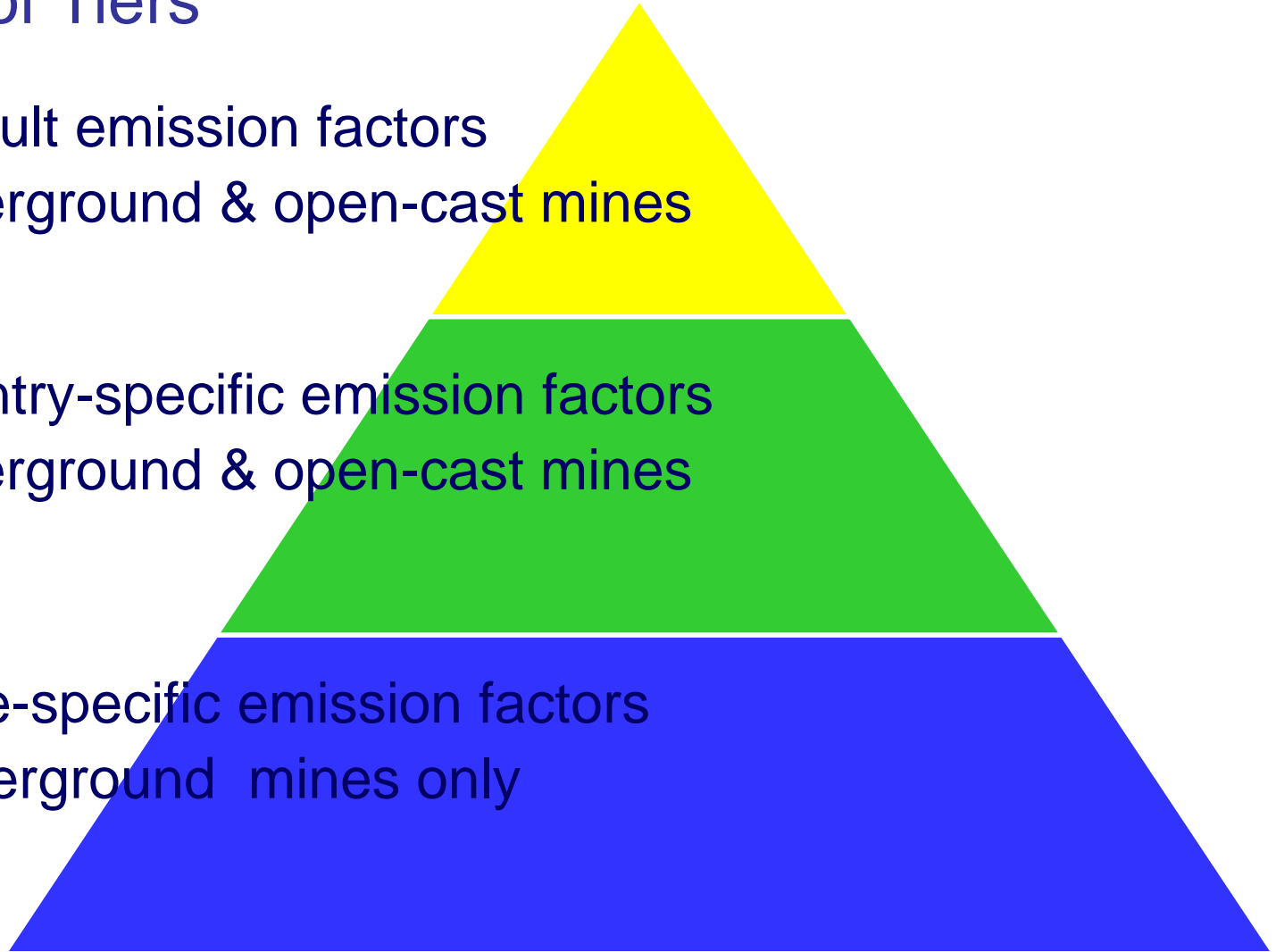
Fugitive Emissions from Coal

➤ Choice of Tiers

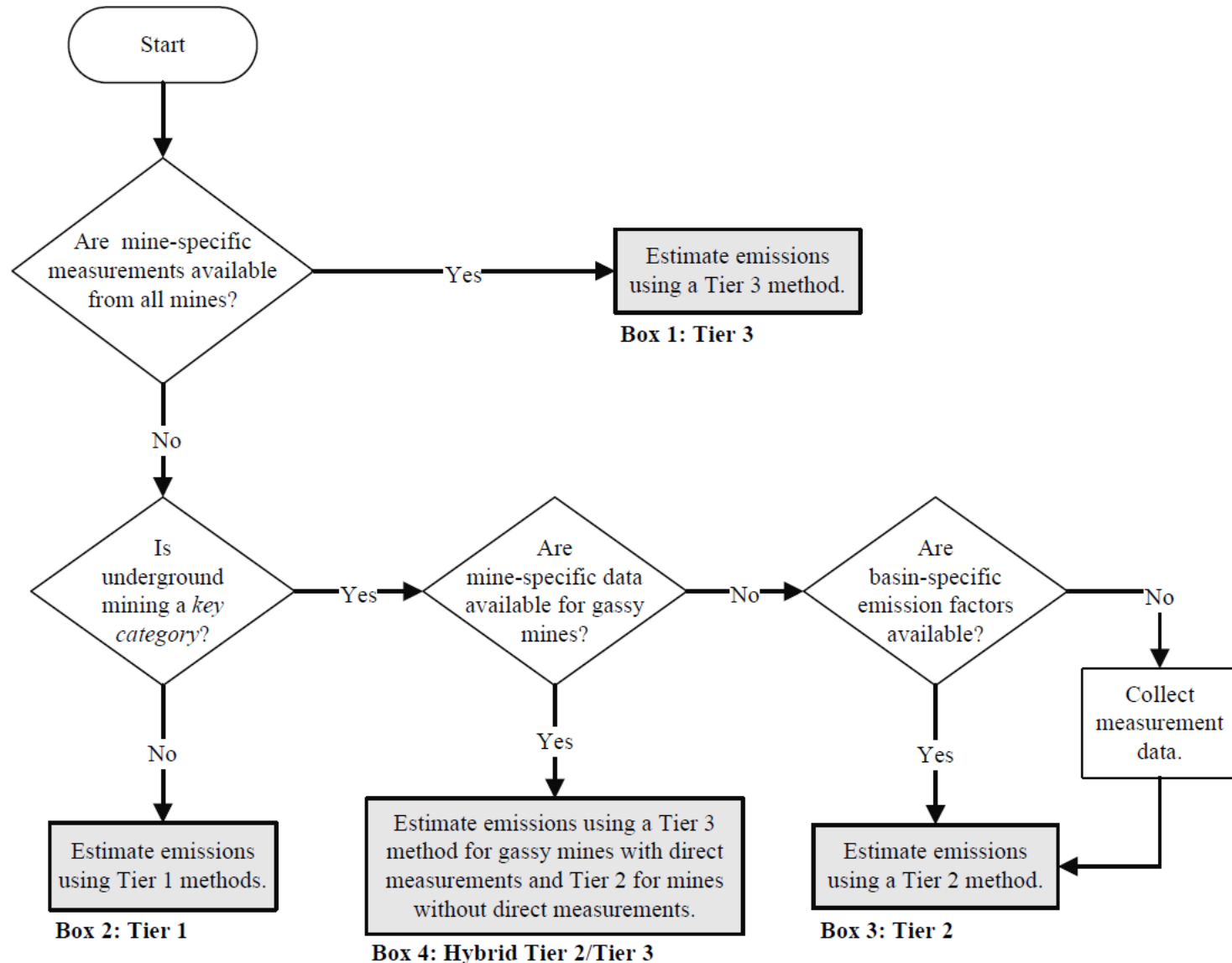
Tier 1 – default emission factors
- underground & open-cast mines

Tier 2 – country-specific emission factors
- underground & open-cast mines

Tier 3 – mine-specific emission factors
– underground mines only



Underground Coal Mine IPCC Decision Tree



IPCC 2006 example – Underground Mining

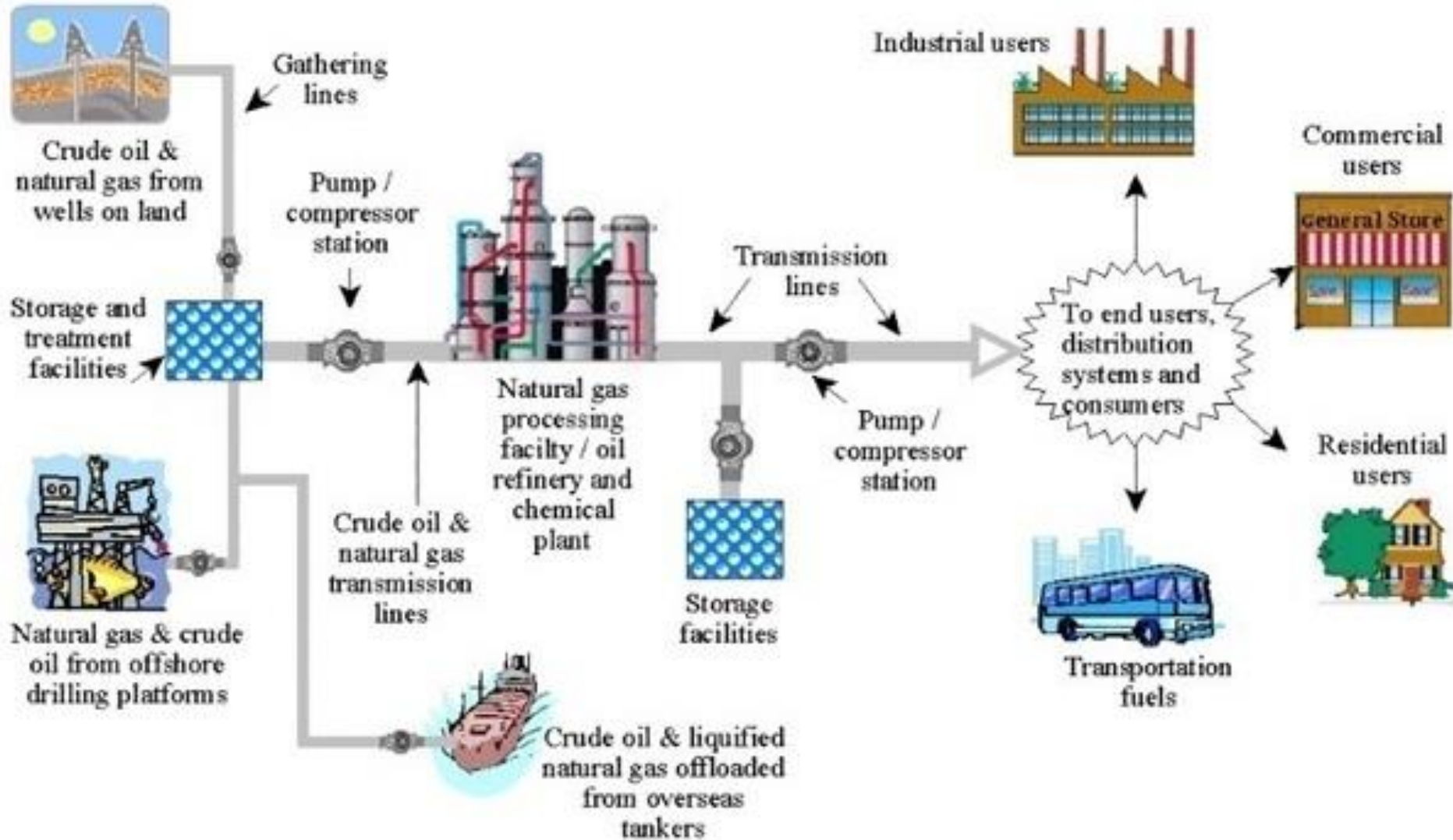
Sector	Energy						
Category	Solid Fuels - Coal Mining and Handling - Underground Mines						
Category Code	1B 1 a i						
Sheet	1 of 3 (CH ₄ and CO ₂ emissions from underground mining activities)						
CH₄ Emissions							
	A	B	C	D	E	F	G
	Amount of Coal Produced (tonne)	Emission Factor	Methane Emissions	Conversion Factor	Methane Emissions	Methane Recovered	Methane Emissions to be Reported
		(m ³ tonne ⁻¹)	(m ³) C = A*B	(Gg CH ₄ m ⁻³)	(Gg CH ₄) E=C*D	(Gg CH ₄)	(Gg CH ₄) G=E-F
Mining (1.B.1.a.i.1)				0.67x10 ⁻⁶			
Post-Mining (1.B.1.a.i.2)				0.67x10 ⁻⁶			
CO₂ Emissions							
	A	B	C	D	E		
	Amount of Coal Produced (tonne)	Emission Factor	CO ₂ Emissions	Conversion Factor	CO ₂ Emissions		
		(m ³ tonne ⁻¹)	(m ³) C=A*B	(Gg CO ₂ m ⁻³)	(Gg CO ₂) E=C*D		
Mining (1.B.1.a.i.1)				1.83x10 ⁻⁶			
Post-Mining (1.B.1.a.i.2)				1.83x10 ⁻⁶			

Fugitive Emissions from Oil & Gas

Fugitive Emissions from Oil & Gas

- Fugitive gas emissions occur at virtually every segment of oil & gas systems, from drilling to the point of sale
- Fugitive gas emissions contribute significant amounts of GHG in all economies, especially in oil & gas producer countries.
- ***NB: Fugitive gases can also come from geothermal & other systems***

Simplified Oil & Gas System



Fugitive Emissions – Natural Gas

- Fugitive GHG emissions stem from the following activities:
 - ❑ Venting
 - ❑ Flaring
 - ❑ Exploration
 - ❑ Production
 - ❑ Transport & Storage
 - ❑ Distribution



Fugitive Emissions - Oil & Gas Sector

- **Gas is flared in oil and gas operations** for a variety of reasons.
 - Routine flaring** of AG (Associated Gas) is a means of disposal when there is lack of markets for the gas
 - Intermittent flaring** – during 'process upsets' or 'unsafe' situations.
- **Flaring takes place in most segments** of oil and gas industries, including:
 - ❑ oil and gas production facilities
 - ❑ gas processing facilities
 - ❑ LNG (liquefied natural gas) and
 - ❑ GTL (gas to liquid) plants, and refineries.

Fugitive Emissions – Natural Gas

IPCC

1.B.2.b - Natural Gas

1.B.2.b.i - Venting

1.B.2.b.ii - Flaring

1.B.2.b.iii - All Other

1.B.2.b.iii.1 - Exploration

1.B.2.b.iii.2 - Production

1.B.2.b.iii.3 - Processing

1.B.2.b.iii.4 - Transmission and Storage

1.B.2.b.iii.5 - Distribution

1.B.2.b.iii.6 - Other

Fugitive Emissions - Oil Sector

- Fugitive GHG emissions stem from the following activities:
 - ❑ Venting
 - ❑ Flaring
 - ❑ Exploration
 - ❑ Production/Upgrading
 - ❑ Transport
 - ❑ Refining
 - ❑ Distribution of refined products



Fugitive Emissions - Oil Sector IPCC

[-] 1.B.2 - Oil and Natural Gas

[-] 1.B.2.a - Oil

..... 1.B.2.a.i - Venting

..... 1.B.2.a.ii - Flaring

[-] 1.B.2.a.iii - All Other

..... 1.B.2.a.iii.1 - Exploration

..... 1.B.2.a.iii.2 - Production and Upgrading

..... 1.B.2.a.iii.3 - Transport

..... 1.B.2.a.iii.4 - Refining

..... 1.B.2.a.iii.5 - Distribution of oil products

..... 1.B.2.a.iii.6 - Other

Fugitive Emissions from Oil & Gas

➤ Choice of Tiers

Tier 1 – default emission factors

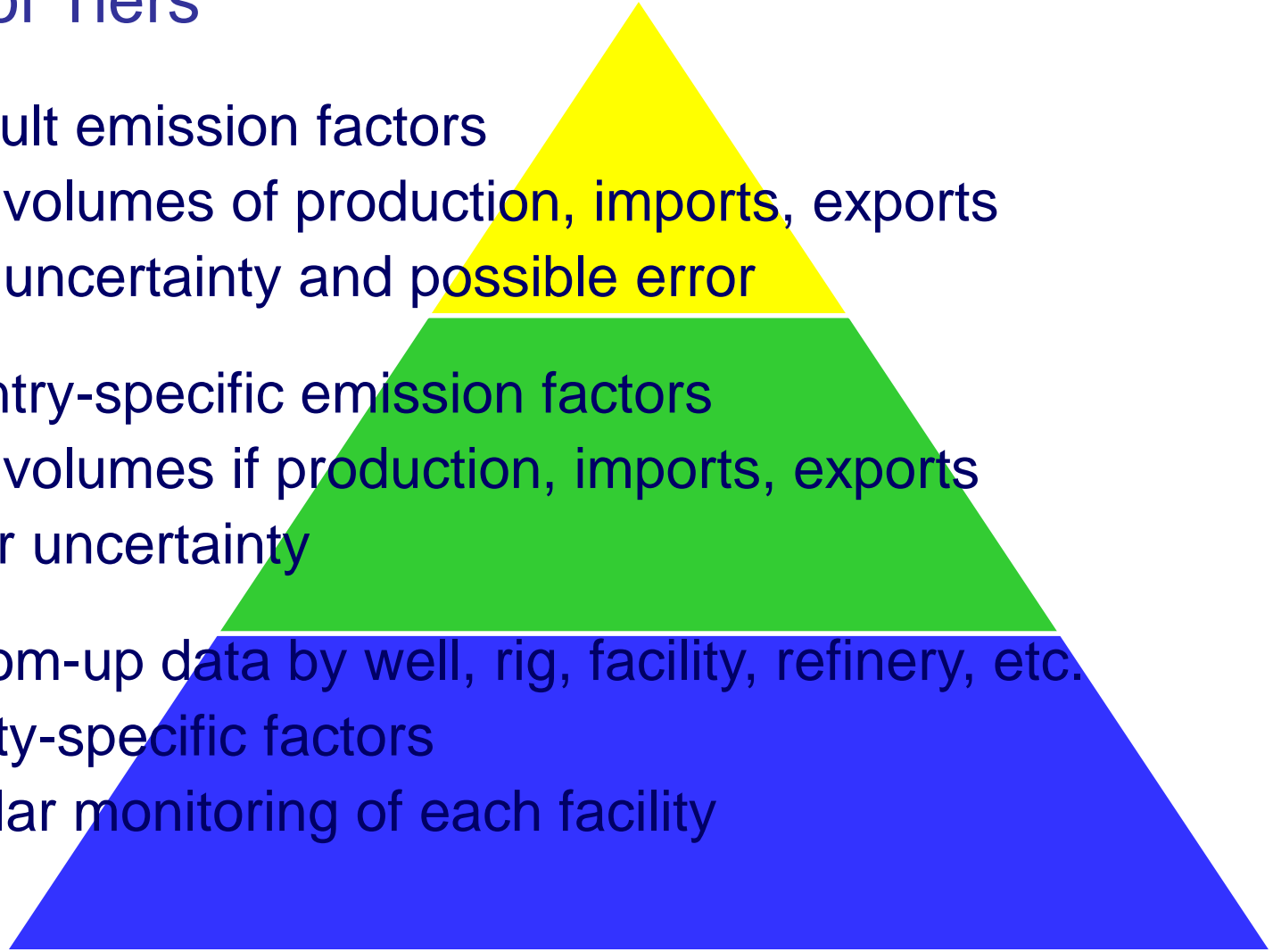
- total volumes of production, imports, exports
- high uncertainty and possible error

Tier 2 – country-specific emission factors

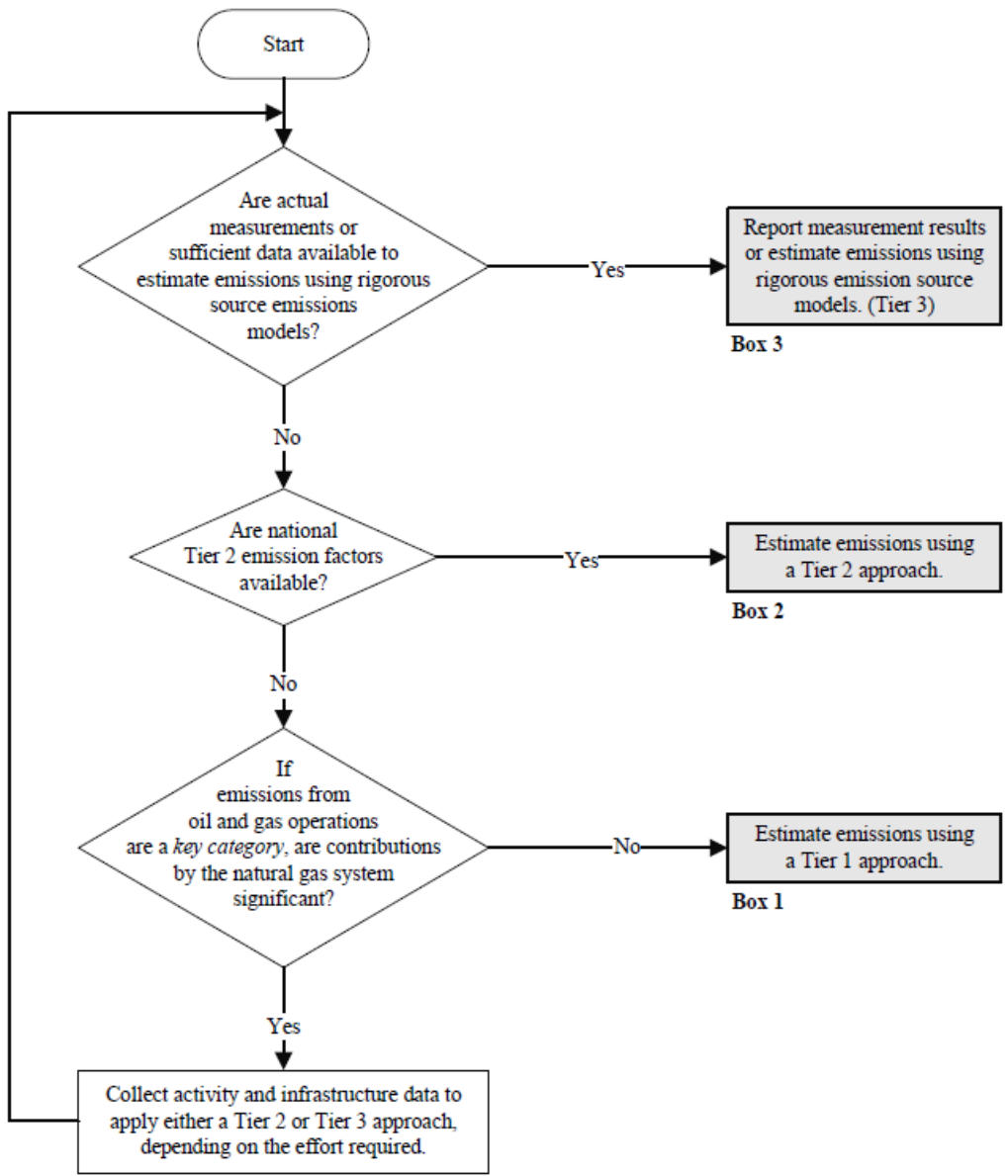
- total volumes of production, imports, exports
- lower uncertainty

Tier 3 – bottom-up data by well, rig, facility, refinery, etc.

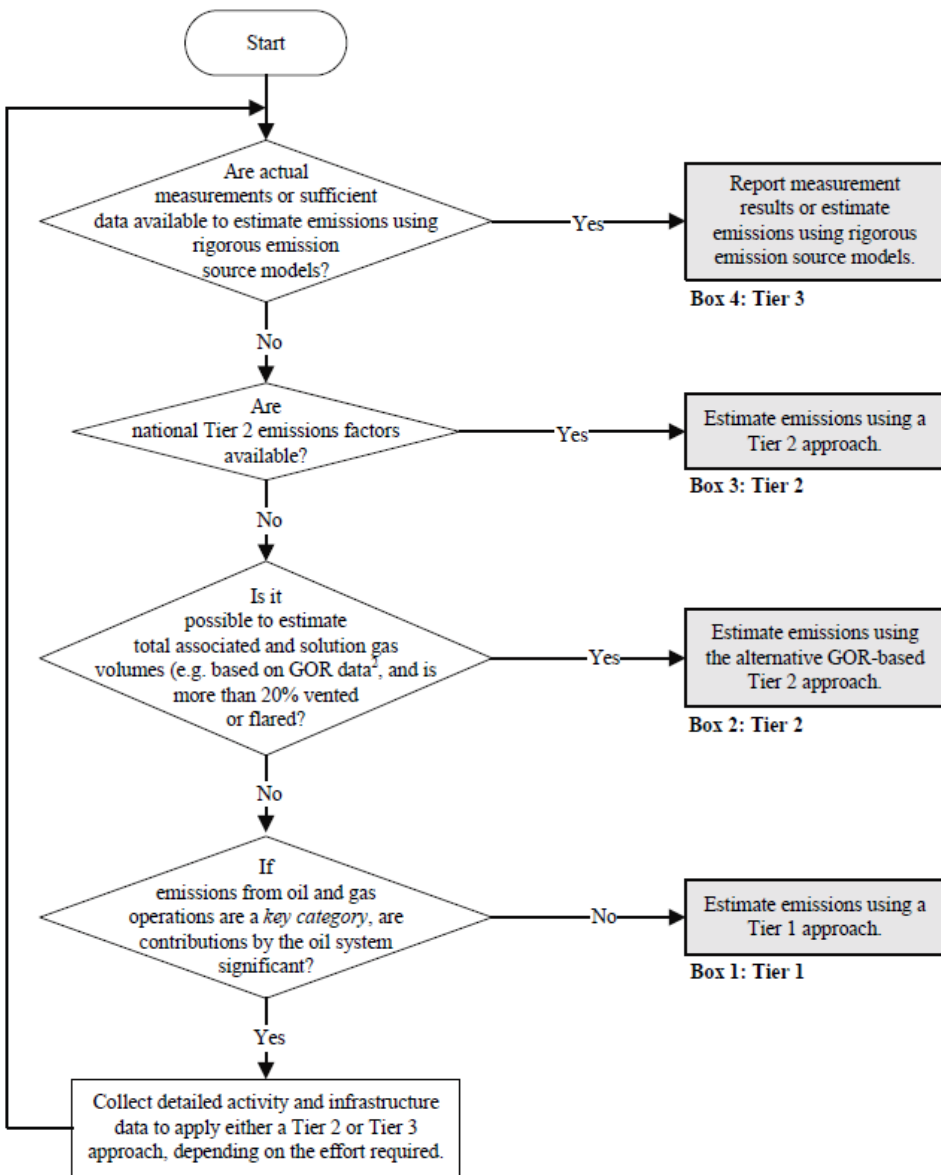
- facility-specific factors
- regular monitoring of each facility



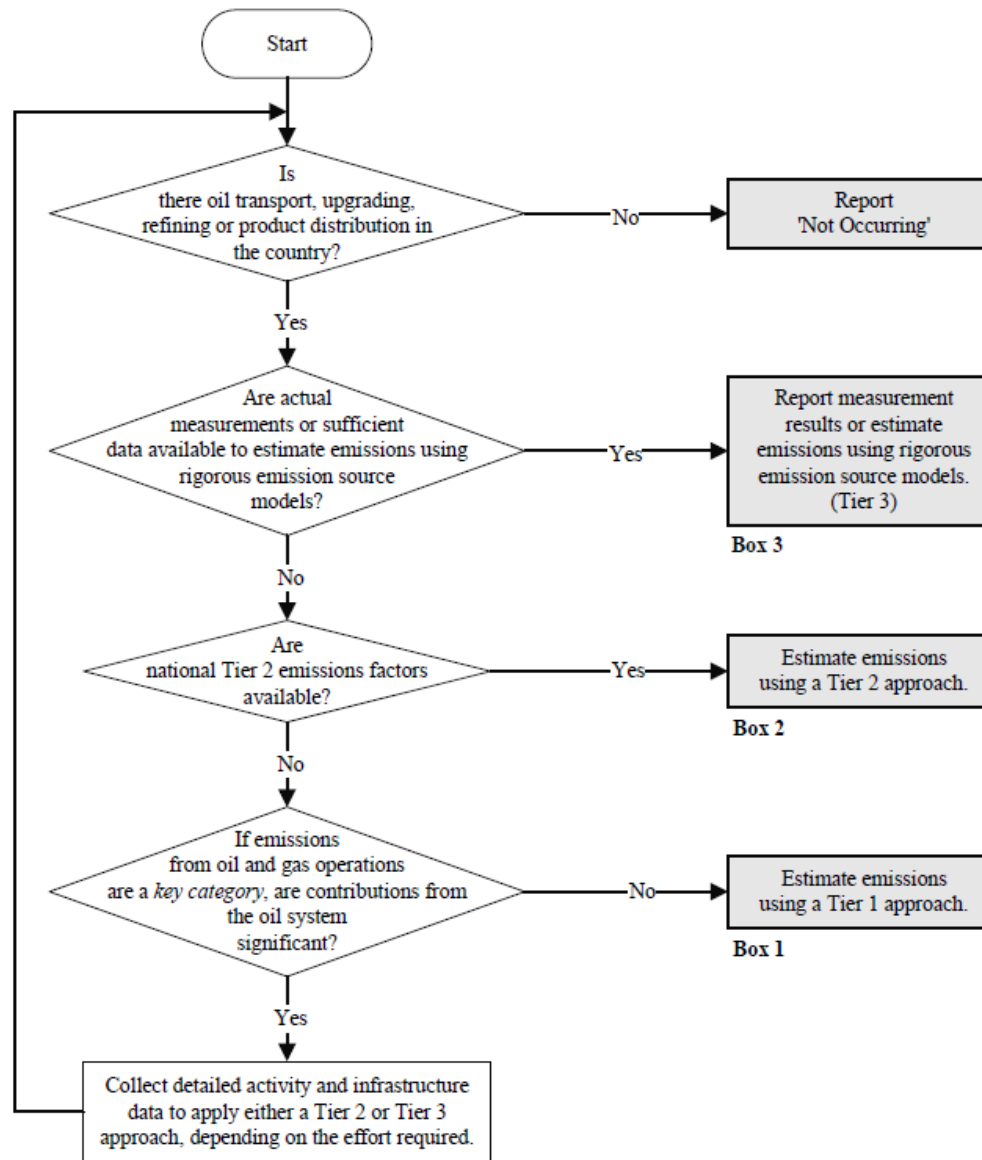
Decision Tree - Natural Gas



Decision Tree - Crude Oil



Decision Tree - Crude Oil: Transport, Refining & Upgrading



Fugitive Emissions - Emission factors

➤ IPCC 2006 – default Tier 1 factors

- ❑ Chapter 4 - **Table 4.2.5** for Developing countries
- ❑ Many emission factors: NA (not available) / ND (not defined)

TABLE 4.2.5
TIER 1 EMISSION FACTORS FOR FUGITIVE EMISSIONS (INCLUDING VENTING AND FLARING) FROM OIL AND GAS OPERATIONS
IN DEVELOPING COUNTRIES AND COUNTRIES WITH ECONOMIES IN TRANSITION^{a,b}

Category	Sub-category ^c	Emission source	IPCC Code	CH ₄		CO ₂ ⁱ		NMVOC		N ₂ O		Units of measure
				Value	Uncertainty (% of value)	Value	Uncertainty (% of value)	Value	Uncertainty (% of value)	Value	Uncertainty (% of value)	
Well Drilling	All	Flaring and Venting	1.B.2.a.ii or 1.B.2.b.ii	3.3E-05 to 5.6E-04	-12.5 to +800%	1.0E-04 to 1.7E-03	-12.5 to +800%	8.7E-07 to 1.5E-05	-12.5 to +800%	ND	ND	Gg per 10 ³ m ³ total oil production
Well Testing	All	Flaring and Venting	1.B.2.a.ii or 1.B.2.b.ii	5.1E-05 to 8.5E-04	-12.5 to +800%	9.0E-03 to 1.5E-01	-12.5 to +800%	1.2E-05 to 2.0E-04	-12.5 to +800%	6.8E-08 to 1.1E-06	-10 to +1000%	Gg per 10 ³ m ³ total oil production
Well Servicing	All	Flaring and Venting	1.B.2.a.ii or 1.B.2.b.ii	1.1E-04 to 1.8E-03	-12.5 to +800%	1.9E-06 to 3.2E-05	-12.5 to +800%	1.7E-05 to 2.8E-04	-12.5 to +800%	ND	ND	Gg per 10 ³ m ³ total oil production
Gas Production	All	Fugitives ^d	1.B.2.b.iii.2	3.8E-04 to 2.4E-02	-40 to +250%	1.4E-05 to 1.8E-04	-40 to +250%	9.1E-05 to 1.2E-03	-40 to +250%	NA	NA	Gg per 10 ⁶ m ³ gas production
		Flaring ^e	1.B.2.b.ii	7.6E-07 to 1.0E-06	±75%	1.2E-03 to 1.6E-03	±75%	6.2E-07 to 8.5E-07	±75%	2.1E-08 to 2.9E-08	-10 to +1000%	Gg per 10 ⁶ m ³ gas production
	Sweet Gas	Fugitives	1.B.2.b.iii.3	4.8E-04 to 1.1E-03	-40 to +250%	1.5E-04 to 3.5E-04	-40 to +250%	2.2E-04 to 5.1E-04	-40 to +250%	NA	NA	Gg per 10 ⁶ m ³ raw gas feed

IPCC 2006 sample – Crude Oil

Sector		Energy							
Category		Oil and natural gas							
Category Code		1B 2							
Sheet		1 of 2							
			CO ₂			CH ₄		N ₂ O	
IPCC Code	Sector Name	Subcategory	A Activity	B Emission Factor	C Emissions (Gg)	D Emission Factor	E Emissions (Gg)	F Emission Factor	G Emissions (Gg)
					$C=A*B$		$E=A*D$		$G=A*F$
1.B.2	Oil and Natural Gas								
1.B.2.a	Oil								
1.B.2.a.i	Venting								
1.B.2.a.ii	Flaring								
1.B.2.a.iii	All Other								
1.B.2.a.iii.1	Exploration								
1.B.2.a.iii.2	Production and Upgrading								
1.B.2.a.iii.3	Transport								
1.B.2.a.iii.4	Refining								
1.B.2.a.iii.5	Distribution of oil products								
1.B.2.a.iii.6	Other								
				TOTAL		TOTAL		TOTAL	

Thank you!

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