6.3 Proposed data collection of fugitive emissions, and carbon transportation and sequestration

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Outline

- Background
- Fugitive emissions
- CO_2 transport, injection and geological storage
- Summary

Fugitive emissions

Definition

- Intentional or unintentional release of greenhouse gases during extraction, processing and delivery of fossil fuels to the demand point.
- Typically, most of the emissions come from production and processing activities than downstream activities.
- Equipment leaks, evaporation and flashing losses, venting, flaring, incineration and accidental releases (blow-outs, spills, etc) are also the source of fugitive emissions.
- Quantity of fugitive emissions is typically subject to significant uncertainty, due to limited measurements being carried out.

Some examples of fugitive emissions

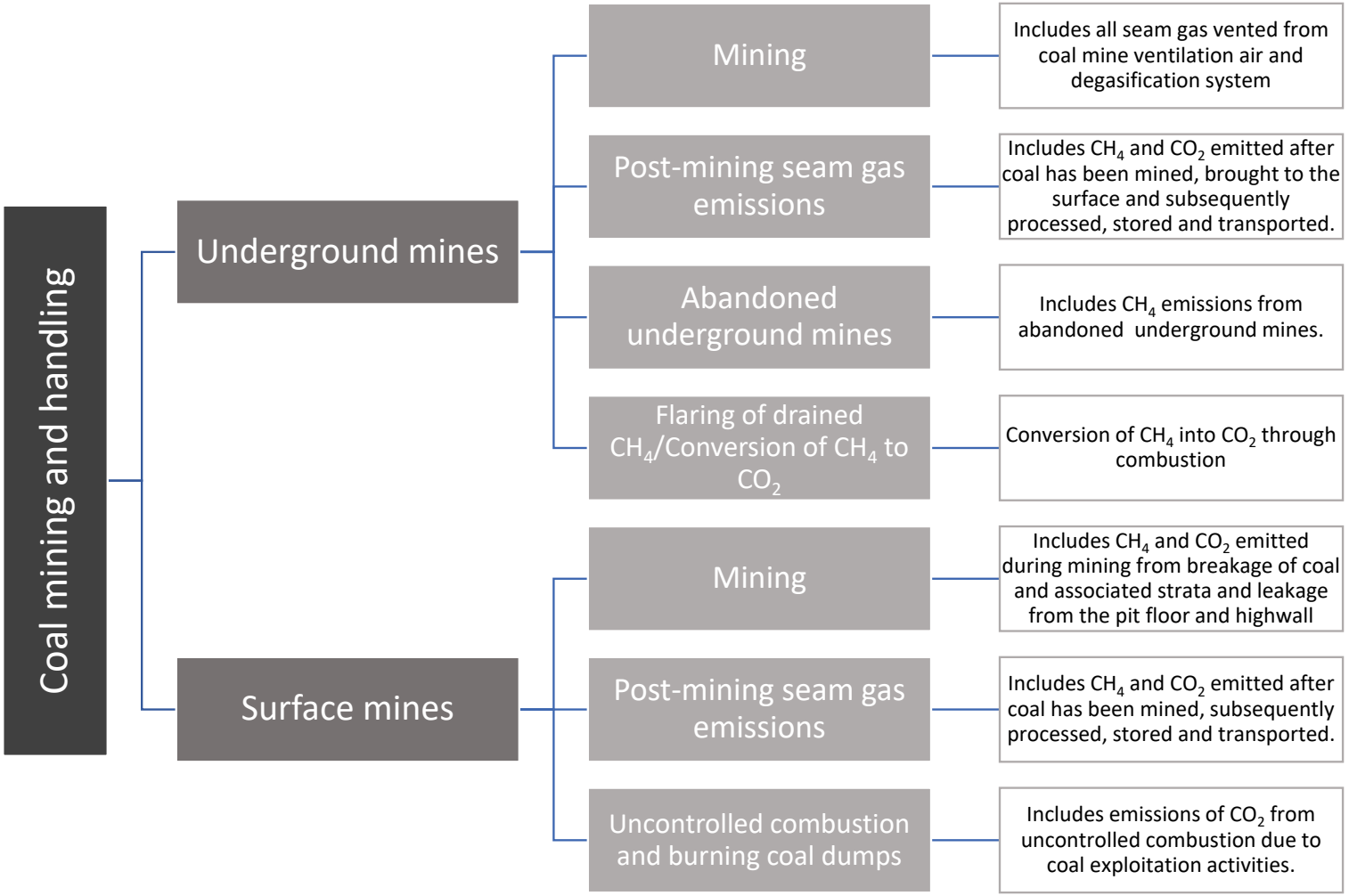
A Matador Production facility leak in New Mexico

Accidental release at Apache Corp. Cheyenne Central Processing Facility

Venting from the tank vent at Energy Transfer Hoban Gin Compressor Station

APERC

Coal mining and handling (1B.1)



Source: IPCC (2006)

Estimating emissions from underground mines

- Emissions from underground coal mines are estimated based on underground coal production activity data and default emission factors. (Tier 1)

Mining/Post-Mining

Source: IPCC (2006)

$$CH_4\ emissions = Underground\ coal\ production\ x\ CH_4\ emission\ factor\ x\ Conversion\ factor$$

Thousand tonne	Tonne	Mining: 18 m^3/tonne Post-mining: 2.5 m^3/tonne	0.67 x 10^{-6} thousand tonnes/m^3

- For Tier 2, basin-specific emission factors may be obtained from sample ventilation air data, along with raw coal production data.
- In addition, post-mining emissions consider the in-situ gas content of the coal

Estimating emissions from underground mines

Abandoned underground mines

- Main parameters used to estimate emissions from any abandoned mines are
  - Time elapsed since the mine was abandoned, relative to the year of emissions inventory;
  - Emission factors that consider the mine's gassiness.
- Tier 1 includes default values and broader time intervals. Following equation is for a given inventory year.,

$$CH_4\ emissions = Number.of\ abandoned\ coal\ mines\ remaining\ unflooded\ x \\ Fraction\ of\ gassy\ coal\ mines\ x\ emission\ factor\ x\ Conversion\ factor$$

- Tier 2 incorporates coal-type-specific information and narrower time intervals for abandonment of coal mines.

Estimating emissions from underground mines

Abandoned underground mines

- Tier 3 requires mine specific information
  - Database for gassy abandoned mines
  - Hydrologic (flooding) status, permeability mine condition (sealed or vented)
  - Mine- or coal basin-specific emission rate decline curves.
  - Field measurements
  - Emissions inventory calculation for each mine
  - Adjustment of emissions reductions due to methane recovery and utilisation
  - Determining the net total emissions.

Estimating emissions from surface mines

- Emissions from surface coal mines are estimated based on surface coal production activity data (Tier 1).

Mining/Post-Mining

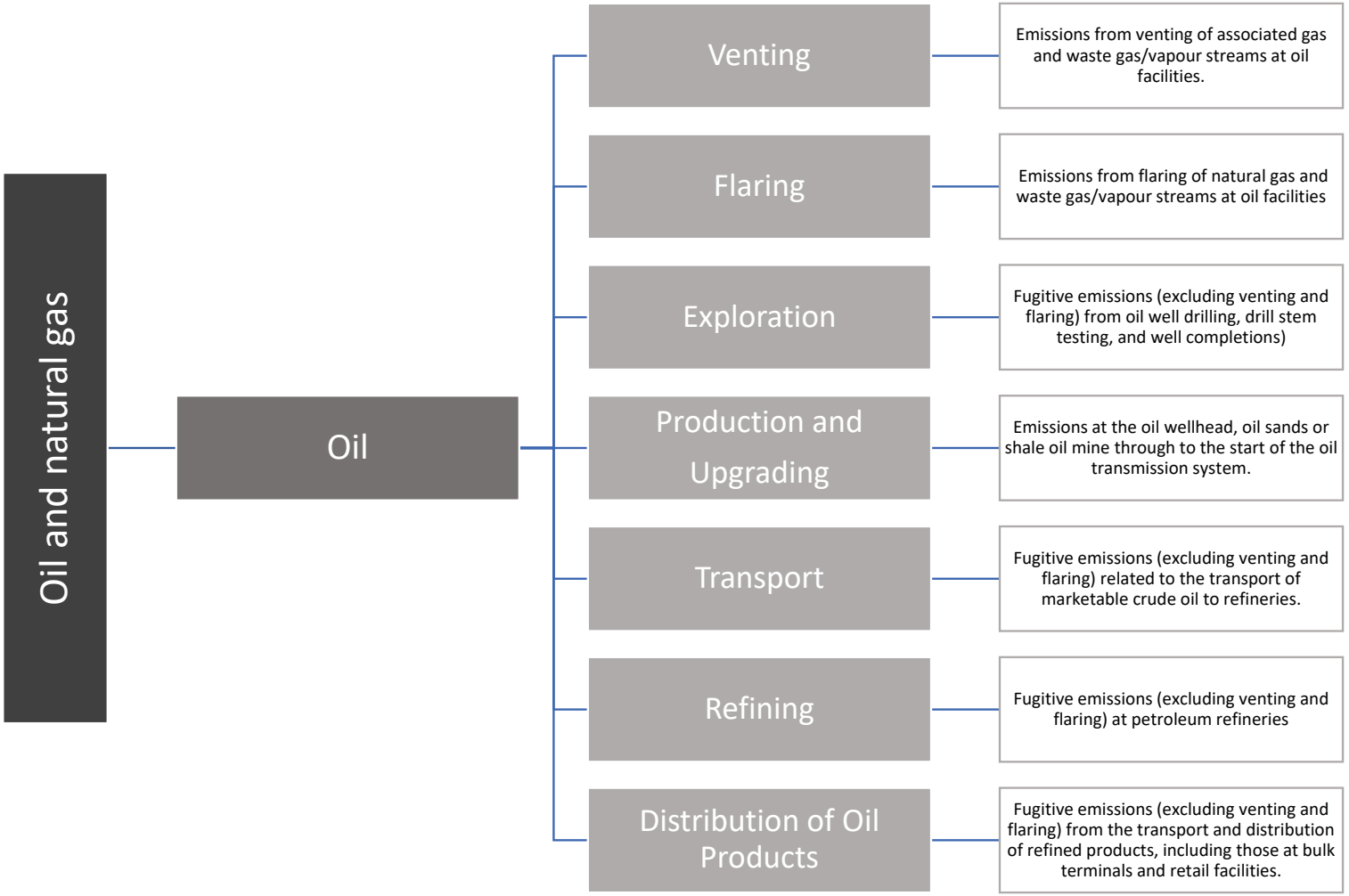
$$CH_4\ emissions = Surface\ coal\ production\ x\ CH_4\ emission\ factor\ x\ Conversion\ factor$$

Thousand tonne	Tonne	Mining: 1.2 m^3/tonne Post-mining: 0.1 m^3/tonne	0.67 x 10^{-6} thousand tonnes/m^3

Source: IPCC (2006)

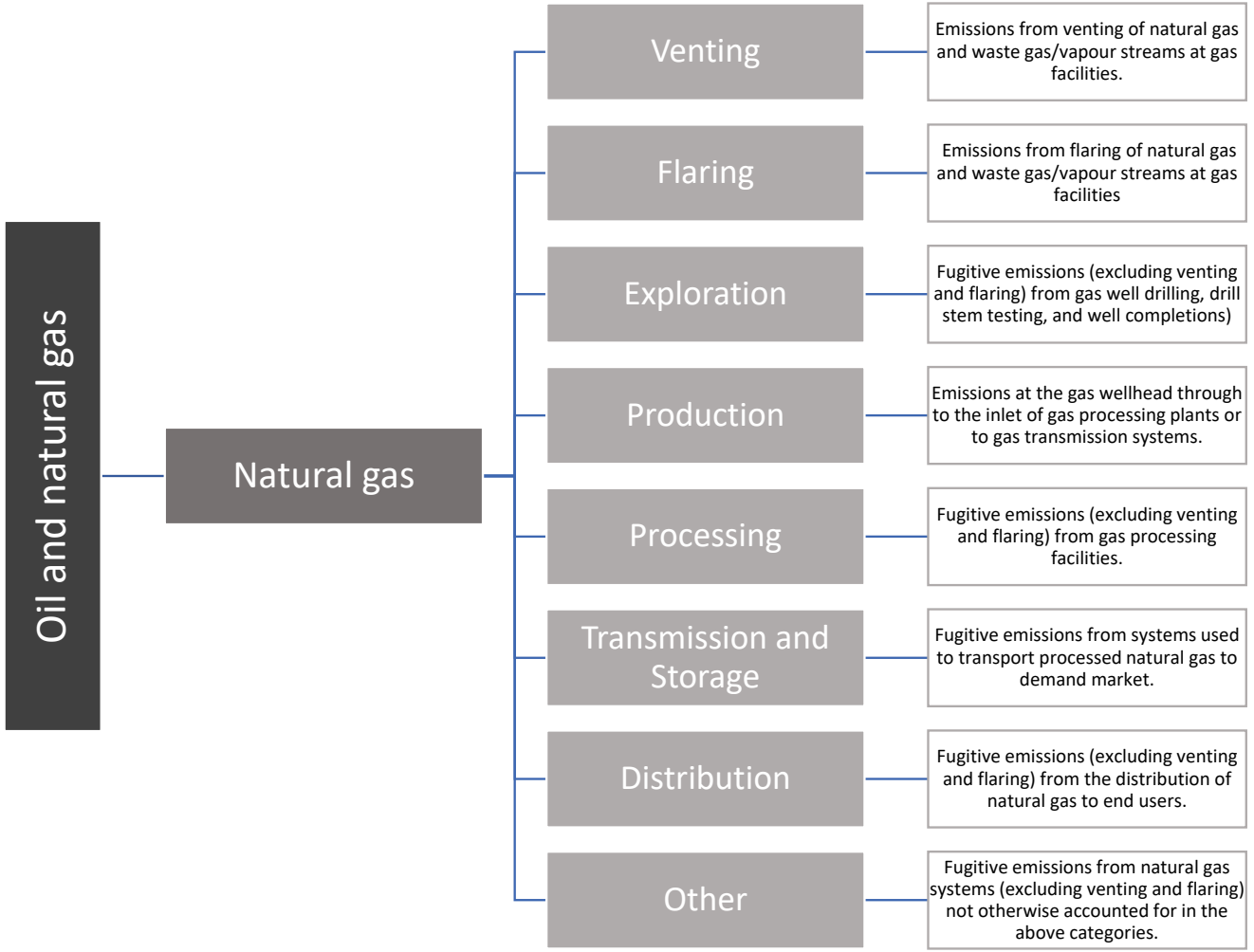
- For Tier 1, it is good practice to use emission factors of
  - low end for mines with average depths of < 25 m, and
  - high end for mines with average depths of > 50 m.
  - average for intermediate depths.
- Tier 2 uses the data disaggregated to the coal basin level.

Oil and natural gas (1B.1)



Source: IPCC (2006)

Oil and natural gas (1B.1) (cont'd)



Estimating emissions from oil and gas

Tier 1

- Tier 1 (simplest method) uses default emission factors for each applicable segment in the following equation.

TIER 1: ESTIMATING FUGITIVE EMISSIONS FROM AN INDUSTRY SEGMENT

$$E_{gas,\,industry\ segment} = A_{industry\ segment} \bullet EF_{gas,\,industry\ segment}$$

Source: IPCC (2006)

$E_{gas,\,industry\ segment}$	$A_{industry\ segment}$	$EF_{gas,\,industry\ segment}$
Annual emissions (thousand tonnes)	Activity value (units of activity)	Emission factor (thousand tonnes/unit of activity)

- Segments considered are listed in the next slide.

Major categories and subcategories in the oil and gas industry

Industry Segment	Sub-Categories
Well Drilling	All
Well Testing	All
Well Servicing	All
Gas Production	Dry Gas[a]
	Coal Bed Methane (Primary and Enhanced Production)
	Other enhanced gas recovery
	Sweet Gas[b]
	Sour Gas[c]
Gas Processing	Sweet Gas Plants
	Sour Gas Plants
	Deep-cut Extraction Plants[d]
Gas Transmission & Storage	Pipeline Systems
	Storage Facilities
Gas Distribution	Rural Distribution
	Urban Distribution
Liquefied Gases Transport	Condensate
	Liquefied Petroleum Gas (LPG)
	Liquefied Natural Gas (LNG) (including associated liquefaction and gasification facilities)
Oil Production	Light and Medium Density Crude Oil (Primary, Secondary and Tertiary Production)
	Heavy Oil (Primary and Enhanced Production)
	Crude Bitumen (Primary and Enhanced Production)
	Synthetic Crude Oil (From Oil Sands)
	Synthetic Crude Oil (From Oil Shales)
Oil Upgrading	Crude Bitumen
	Heavy Oil
Waste Oil Reclaiming	All
Oil Transport	Marine
	Pipelines
	Tanker Trucks and Rail Cars
Oil Refining	Heavy Oil
	Conventional and Synthetic Crude Oil
Refined Product Distribution	Gasoline
	Diesel
	Aviation Fuel
	Jet Kerosene
	Gas Oil (Intermediate Refined Products)

Not all segments will necessarily apply to all economies.

Source: IPCC (2006)

Estimating emissions from oil and gas

Tier 2

- Using the same equations as in Tier 1 method but with economy-specific emission factors.
- Emission factors may be determined from studies and measurements.
- Tier 2 also estimates emissions from venting and flaring using a mass balance via production volumes, gas-to-oil ratios (GORs), gas compositions and gas conservation.

EQUATION 4.2.3
ALTERNATIVE TIER 2 APPROACH (EMISSIONS DUE TO VENTING)

$$E_{gas,oil\ prod,\ venting} = GOR \bullet Q_{OIL} \bullet (1-CE) \bullet (1-X_{Flared}) \bullet M_{gas} \bullet y_{gas} \bullet 42.3 \times 10^{-6}$$

EQUATION 4.2.4
ALTERNATIVE TIER 2 APPROACH (CH_4 EMISSIONS DUE TO FLARING)

$$E_{CH4,oil\ prod,flaring} = GOR \bullet Q_{OIL} \bullet (1-CE) \bullet X_{Flared} \bullet (1-FE) \bullet M_{CH4} \bullet y_{CH4} \bullet 42.3 \times 10^{-6}$$

EQUATION 4.2.5
ALTERNATIVE TIER 2 APPROACH (CO_2 EMISSIONS DUE TO FLARING)

$$E_{CO2,\ oilprod,flaring} = GOR \bullet Q_{OIL} \bullet (1-CE) \bullet X_{Flared} \bullet M_{CO2} \bullet \left[y_{CO2} + (Nc_{CH4} \bullet y_{CH4} + Nc_{NMVOC} \bullet y_{NMVOC})(1-X_{Soot})\right] \bullet 42.3x10^{-6}$$

EQUATION 4.2.6
CH_4 EMISSIONS FROM FLARING AND VENTING

$$E_{CH4,oil\ prod} = E_{CH4,oil\ prod,venting} + E_{CH4,oil\ prod,flaring}$$

EQUATION 4.2.7
CO_2 EMISSIONS FROM VENTING AND FLARING

$$E_{CO2,oil\ prod} = E_{CO2,oil\ prod,venting} + E_{CO2,oil\ prod,flaring}$$

EQUATION 4.2.8
N_2O EMISSIONS FROM FLARING

$$E_{N2O,oil\ prod,flaring} = GOR \bullet Q_{OIL}(1-CE)X_{Flared}EF_{N2O}$$

Source: IPCC (2006)

Estimating emissions from oil and gas

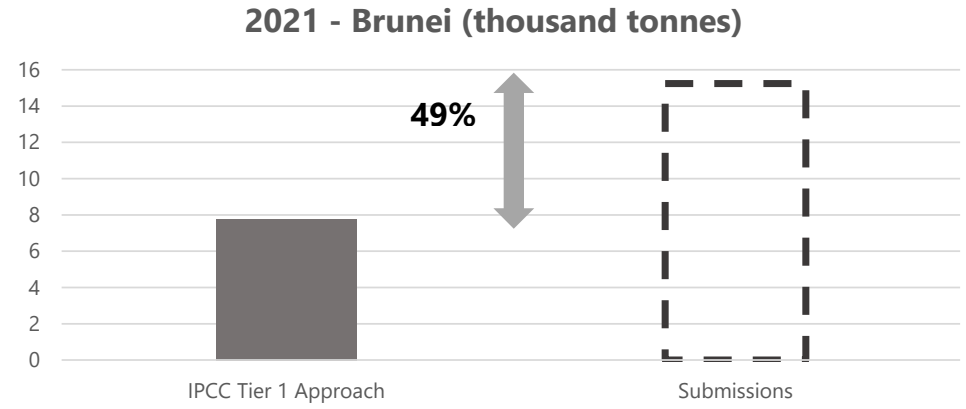
Tier 3

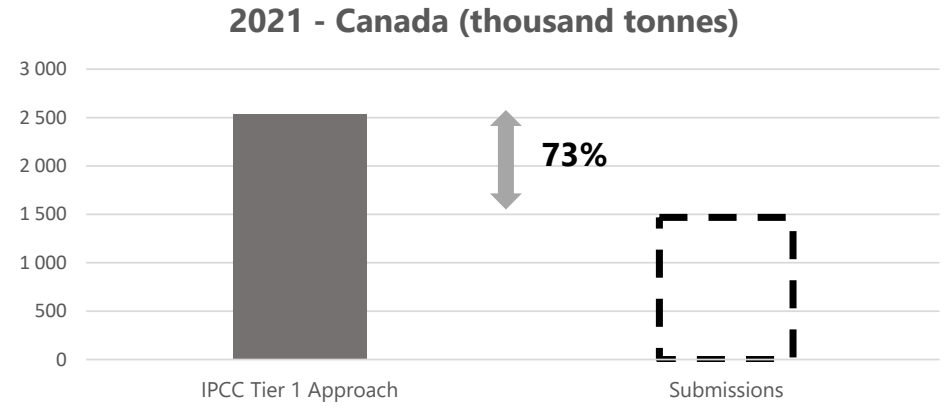
- Bottom-up assessment by primary type of source (venting, flaring, equipment leaks, evaporation losses, accidental releases) at individual facility.
- Key types of data include:
  - Facility inventory
  - Inventory of wells and minor field installations (dehydrators, line heaters, well site metering, etc)
  - Country-specific flare, vent, and process gas analyses
  - Acid gas production, analyses and disposition data
  - Reported atmospheric releases due to well blow-outs and pipeline ruptures.
  - Country-specific emission factors for leaks, venting and flaring, flashing losses, evaporation loses, etc.
  - Amount and composition of acid gas that is injected into secure underground formations for disposal.

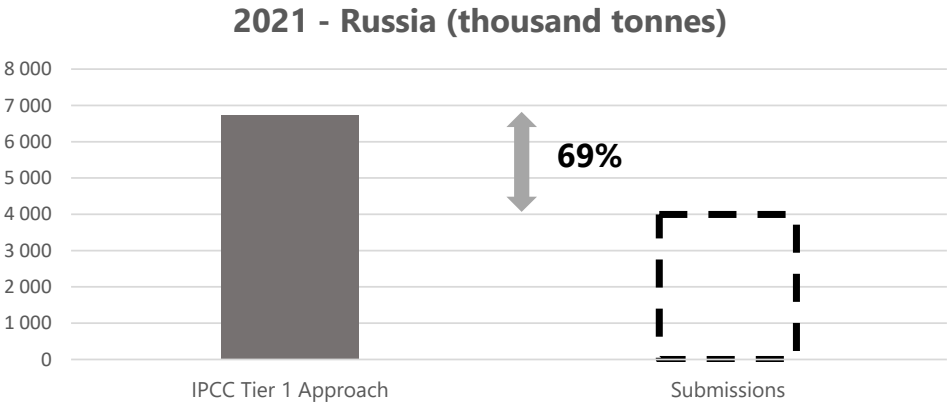
Issues with Tier 1 approach

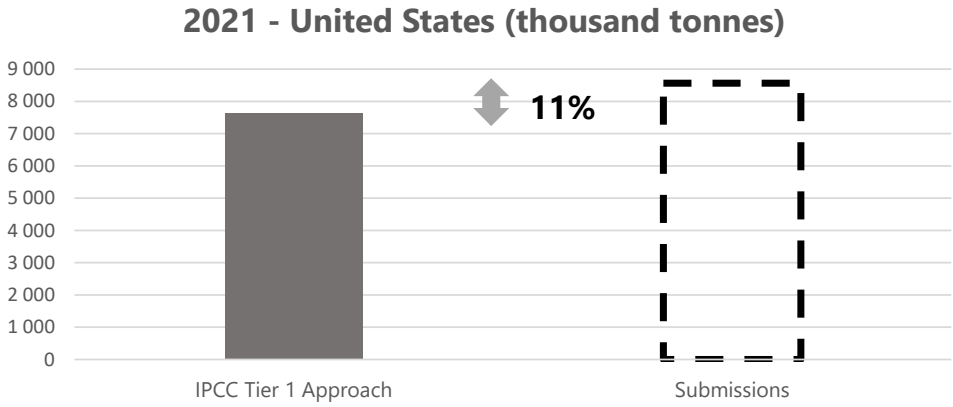
- High degree of uncertainty in emission factors.
- Reliability of emission factors for oil and gas systems depend greatly in the size of an economy's oil and gas industry.
- Fugitive emissions will be important for an oil and gas-dependent economy, and hence emission factors shall be as accurate as possible.
- Approach also does not allow for showing any real changes in emission intensities time, i.e. emissions become fixed in proportion to the production levels.
- Going into Tiers 2 and 3 requires more detailed activity data, and hence more effort and cost needed.

Large differences between reported and Tier 1-based fugitive CH_4 emissions in selected member economies





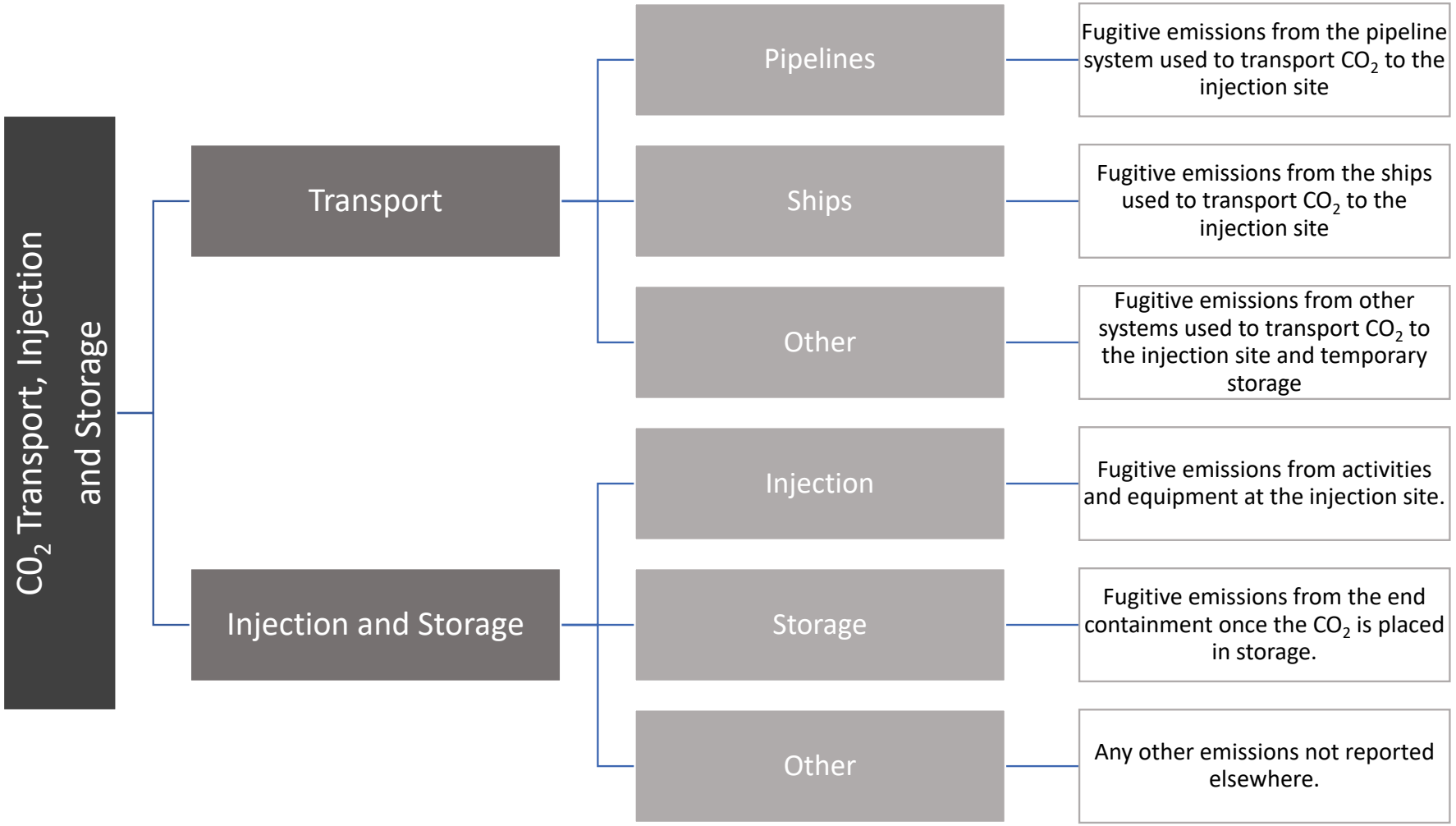




Source: IPCC, UNFCCC (2023)

CO_2 transport, injection and geological storage

Source categories for CO_2 transport, injection and storage



Estimating emissions from transport of CO_2 by pipeline and ship

- For transport by pipeline, the length of the transporting CO_2 pipeline system should be used to estimate emissions (Tier 1).

TABLE 5.2
DEFAULT TIER 1 EMISSION FACTORS FOR PIPELINE TRANSPORT OF CO_2 FROM A CO_2 CAPTURE SITE TO THE FINAL STORAGE SITE

Emission Source	Value			Uncertainty	Units of Measure
	Low	Medium	High		
Fugitive emissions from CO_2 transportation by pipeline	0.00014	0.0014	0.014	± a factor of 2	Gg per year and per km of transmission pipeline

- Default emission factors for fugitive emissions from CO_2 transport by ship are not available.
- Amount of CO_2 should be metered during loading and unloading, and any losses detected should be reported as fugitives.

Estimating emissions from CO_2 injection and storage

- Amount of CO_2 injected can directly be measured at the wellhead. There is no default method suggested by IPCC.
- CO_2 leakage may occur to the ground surface/seabed from the storage reservoir.
- Although there is insufficient information for guidance to estimate leakages, it is a good practice to conduct appropriate assessment of the potential leakages.

Summary

- Quantity of fugitive emissions is typically subject to significant uncertainty, due to limited measurements being carried out.
- There are large differences in the fugitive emissions submitted by economies against the ones calculated via IPCC's Tier 1 approach.
- Tiers 2 and 3 require specific and more detailed data.
- The secretariat will calculate fugitive emissions using energy balance data and Tier 1 approach, although there will be huge uncertainties in the estimates.
- It is recommended that economies estimate their fugitive emissions using economy-specific emission factors and submit those emissions to the secretariat.

Thank you.

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