Methane emissions from the oil & gas and coal industries: Similarities and differences

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Mitigation of Methane Emissions from the Extractive Industries in Transition:
Concrete Actions, Goals, and the Costs of the Process

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Methane emissions
Oil and gas operations vs coal

Oil and gas CH_4 emissions

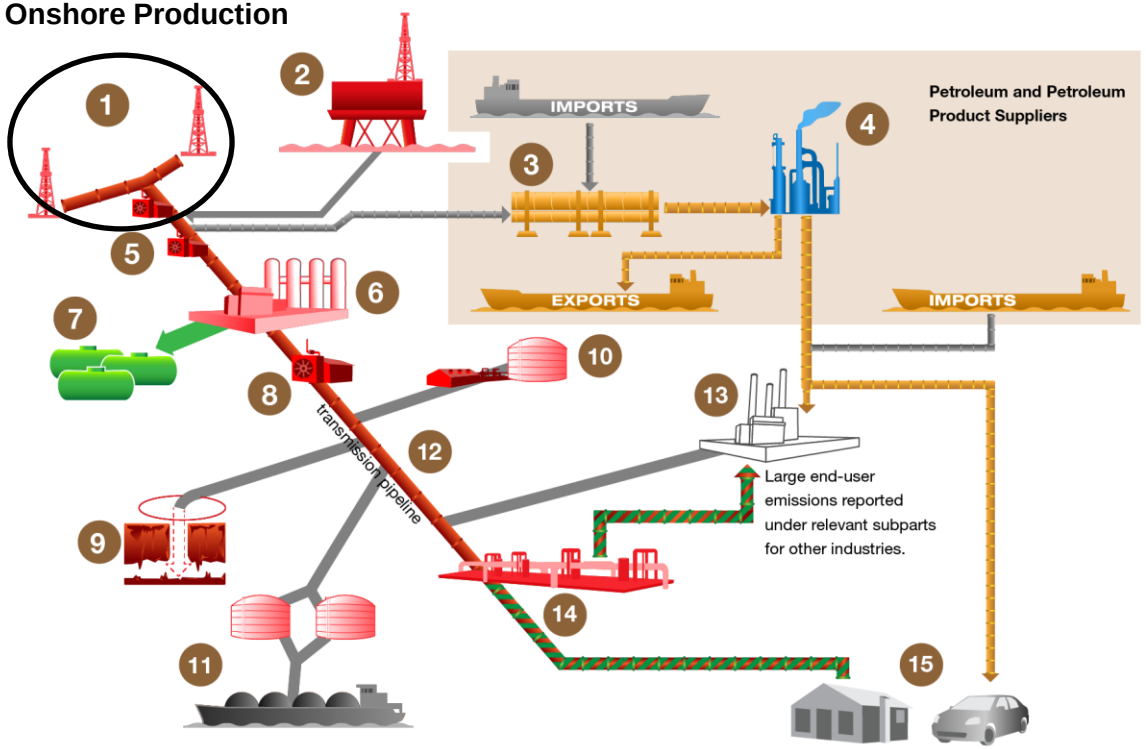
- Emitted from all industry segments
- Majority of facilities assumed to emit some CH_4
- Oil and gas throughput does not necessarily equate to quantity of emissions
- Vented emissions (intentional) and leaks (unintentional)
- CH_4 emitted for safety, due to lack of infrastructure or no market
- Emission sources can be diffuse with emissions from millions of pieces of equipment
- Widely distributed across a large number of countries
- Includes onshore and offshore operations
- Includes large-scale events (e.g.,well blowouts, storage leaks, pipeline ruptures)
- Emissions from plugged/abandoned wells may total 5-10% of onshore production emissions but there is significant uncertainty
- Significant CO_2 emissions from venting and combustion

Coal mining CH_4 emissions

- Emissions primarily from coal production
- Not all coal mines are gassy
- Coal production and emissions are not always directly related
- Vented emissions only, no leaks
- CH_4 is a byproduct of mining and emitted for safety
- Emission sources are concentrated into a small number of vent shafts, degasification system, vent pipes
- Generally limited to major mining countries
- Onshore operations only
- Nothing comparable to O&G major events – a major event would likely cause an explosion at the mine
- Abandoned mines believed to account for 10-20% of emissions from underground mines and abandoned mine methane (AMM) emissions are growing
- Very little CO_2 emissions

Full Supply Chain of the Oil and Gas Industry

Onshore Production



Production & Processing

1. Onshore Petroleum & Natural Gas Production
2. Offshore Petroleum & Natural Gas Production
3. Total Crude Oil to Refineries
4. Petroleum Refining
5. Gathering and Boosting
   *Data collection began in RY 2016
6. Gas Processing Plant
   *May contain NGL Fractionation equipment
7. Natural Gas Liquids (NGL) Supply

Natural Gas Transmission & Storage

8. Transmission Compressor Stations
9. Underground Storage
10. Liquified Natural Gas (LNG) Storage
11. LNG Import-Export Equipment
12. Natural Gas Transmission Pipeline
    *Data collection began in RY 2016

Distribution

13. Large End Users
14. Natural Gas Distribution
15. Natural Gas & Petroleum Supply to Small End Users

- Subpart W: Emissions from petroleum & natural gas systems
- Subpart Y: Emissions from petroleum refineries
- Subpart MM: CO_2 associated with supplies of petroleum products
- Subpart NN: CO_2 associated with supplies of natural gas & natural gas liquids
- Not reported under GHGRP

Source: US EPA

Onshore petroleum and natural gas exploration and production (E&P) segment

*US Greenhouse Gas Inventory (GHGI)**

- *CH_4 emissions from*
  - *47 sources at natural gas E&P operations*
  - *40 sources at oil E&P operations*
- *Sources include:*
  - *drilling and completions*
  - *associated gas venting*
  - *pneumatic controllers and pumps*
  - *liquids unloading*
  - *storage tanks*
  - *dehydrators*
  - *leaks*
  - *compressors*
  - *well blowouts*
  - *other sources*
  - *uncombusted methane*
  - *Other*

Onshore E&P CH_4

96.6 $MtCO_2e$ net emissions*
(6.3) $MtCO_2e$ reductions*
~9300 Facilities**

US GHGI Equipment Counts*

1,514,000	*pneumatic devices*
940,000	*oil & gas wells*
650,800	*tanks*
484,300	*separators*
350,300	*meters of piping*
153,000	*heaters*
123,800	*pumps*
52,100	*gas engines*
38,000	*compressors*
12,400	*dehydrators*

Sources: **Inventory of U.S. Greenhouse Gases and Sinks 1990-2019* US EPA
**Enverus – Facility is defined as all onshore E&P operations at the basins level

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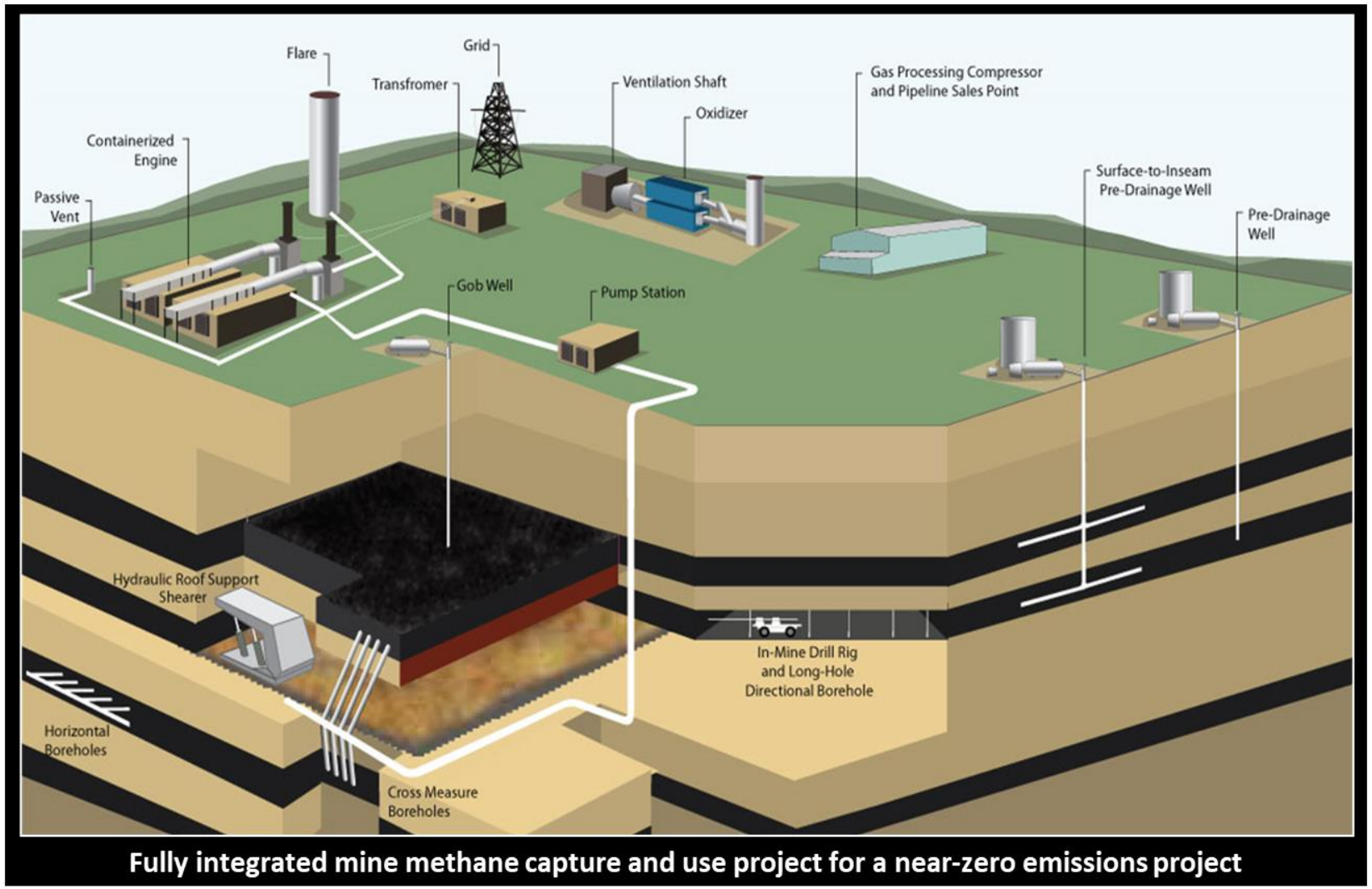
Underground coal operations



Fully integrated mine methane capture and use project for a near-zero emissions project

US CMM Statistics	
350	*Working surface mines*
167	*Gassy working UG mines*
532	*Gassy abandoned UG mines*
53.4	$MtCO_2e$ net emissions
34.5	$MtCO_2e$ from UG mines
6.4	$MtCO_2e$ from surface mines
6.6	$MtCO_2e$ from post-mining
5.9	$MtCO_2e$ from abandoned mines
(15.7)	$MtCO_2e$ recovered and used from working UG mines
(2.6)	$MtCO_2e$ recovered and used from abandoned mines

Source: *Inventory of U.S. Greenhouse Gases and Sinks 1990-2019* US EPA

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Monitoring, measurement of CH_4 emissions Oil and gas operations vs coal

Oil and gas CH_4 emissions

- Due to large number of sources, monitoring/measurement often uses combination of:
  - Emission factors
  - Optical gas imaging and remote sensing
  - Flow meters and sensors
- Low emissions from individual sources collectively adds up to large emission totals
- Some large emission sources can produce significant emissions, e.g., Associated gas venting, Well blowouts.
- Concentration of large emitters among IOCs, NOCs, and major independents has allowed regulators and industry to develop standards such as the Oil and Gas Methane Partnership

Coal mining CH_4 emissions

- Common measurement methods
  - Flow meters and sensors, especially at working UG mines
  - Emission factors
  - Decline curve analysis and statistical analysis at abandoned mines
- Measurement is normal practice for safety
- More focus on remote sensing of methane emissions in recent years
- Major emitting companies in the global coal industry less concentrated than oil and gas

Mitigation of CH_4 emissions
Oil and gas operations vs coal

Oil and gas CH_4 emissions

- O&G industry under significant scrutiny to reduce emissions
- Recovery of saleable product
- Mitigation actions within the normal competency of oil and gas facility operators
- Recovery and use of CH_4 requires
  - Market for the gas
  - Infrastructure such as sufficient pipeline capacity
- Economics are highly dependent on:
  - Price for natural gas
  - Incentives or carbon markets can help
- Flaring is used where recovery for sales is not possible
- Significant emission reductions are achievable, but 100% mitigation probably not possible: Upsets, Necessary blowdowns, Unintended events, Impossible to stop all leaks

Coal mining CH_4 emissions

- More attention has turned to the coal industry in recent years
- CH_4 is a byproduct of mining; industry focused on safety first
- Mitigation actions are not normally within the core competency of owner/operators
- Recovery and use of coal mine methane (CMM) seen as a source of revenue or cost-savings for the mine
  - Predominant use of CMM worldwide is power generation, not gas sales
  - Requires access to markets but CMM can also be used on-site
- Economics are highly dependent on:
  - Price for power, natural gas, LNG, and/or coal
  - Incentives or carbon markets can help
- Mining industry in some countries has begun flaring unused CH_4 but historically this has not been a standard practice due to perceived safety concerns
- Ventilation Air Methane (VAM) remains largest source of coal mine emissions, but few projects worldwide due to technical challenges and need for sustained high carbon prices
- Significant emission reductions are achievable, but 100% mitigation is not possible: Technical limits of mitigation equipment, Need to ensure safety

Thank You

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