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Solutions for Our Climate

Korea's Upsteam Challenge: **Mitigating Global Methane Emissions**

1 Executive Summary

Korea's Upstream Opportunity: Mitigating Global Methane Emissions

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Methane, with a global warming potential up to 82 times greater than carbon dioxide over 20 years, is a significant contributor to climate change, particularly from the Oil & Gas (O&G) industry. The International Energy Agency (IEA) estimates that over 75% of these emissions can be reduced with existing technologies.

In 2021, methane emissions from Korean upstream assets, on an equity basis, were approximately 45% of the domestic energy methane emissions reported in Korea's GHG Inventory (2.9 Mt CO_2e vs. 6.5 Mt CO_2e). Considering that global upstream GHG emissions represent roughly 5% of total oil and gas combustion emissions, this underscores the significant methane emissions from energy value chains involving Korean companies that are not captured in the GHG Inventory.

Between 2019-2023, Korean assets in 8 countries – Iraq, Kazakhstan, Australia, Uzbekistan, Egypt, and the United Arab Emirates (UAE), the United States, and Canada – accounted for approximately 92-95% equity-based yearly upstream methane emissions – Iraq and Kazakhstan were the largest contributors, together representing between 55-70% of estimated total annual emissions.

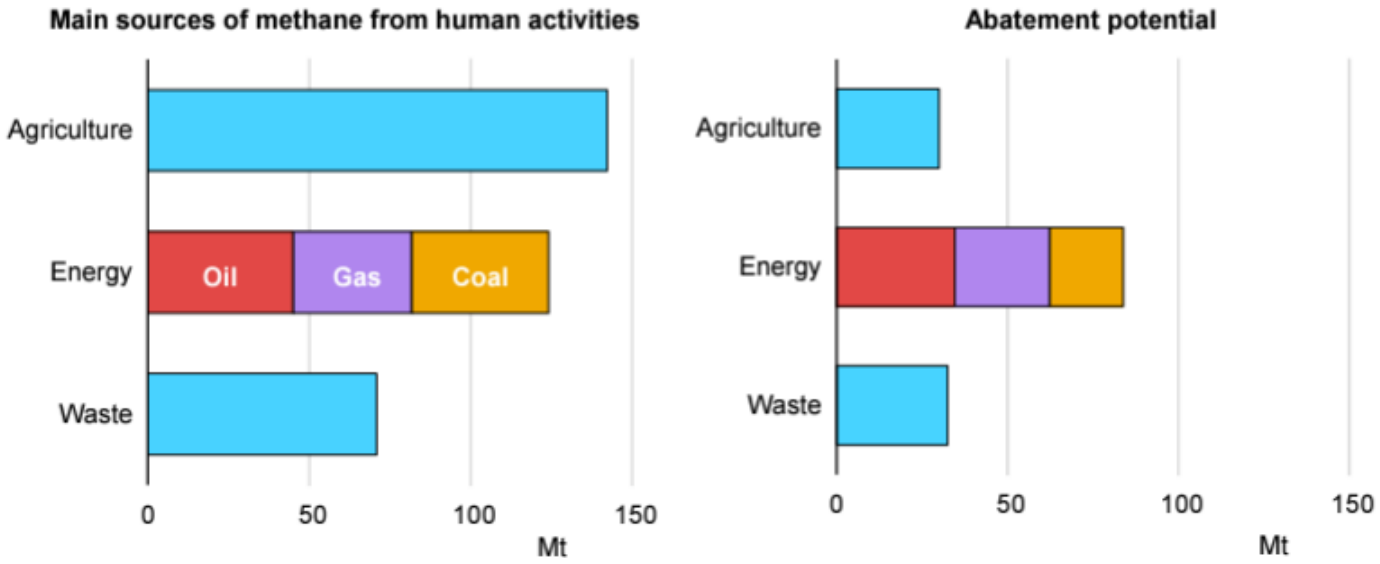
Public companies like the Korea National Oil Corporation (KNOC) and the Korea Gas Corporation (KOGAS) were major contributors to upstream methane emissions but can lead mitigation efforts. Public companies were responsible for approx. 62% of all equity-based Korean O&G production in 2021, which emitted about 86% of all equity-based upstream methane emissions. With close ties to the Korean Government, public companies can play an active role in setting the direction of methane mitigation efforts and show their commitment to Korea's international commitments including the Paris Agreement and Global Methane Pledge.

2 The Energy Methane Challenge

Growing Global Momentum Towards Energy Methane Mitigation

- Methane is a potent greenhouse gas with a global warming potential up to 82 times greater than carbon dioxide over a 20-year period, making it the second most significant contributor to climate change after carbon dioxide.
- Though methane emissions originate from diverse sources, the energy sector holds great potential for low-cost and rapid methane reduction. An analysis by the International Energy Agency (IEA) noted that though fossil fuel operations were the second largest contributor to anthropogenic methane emissions, more than 75% of methane emissions from O&G operations can be abated by existing technology, often at low cost.

Methane Emissions: Main Sources & Current Abatement Potential



Source: IEA (2023b)

2 The Energy Methane Challenge

Growing Global Momentum Towards Energy Methane Mitigation

Recent Global Commitments to Accelerate Methane Mitigation Efforts

- Global Methane Pledge (COP26 – Nov. '21) – Launched by the EU and U.S., with over 158 countries pledging to reduce methane emissions by at least 30% from 2020 levels across the energy, waste, and agriculture sectors.
- More than 50 oil and gas companies join the Oil and Gas Decarbonization Charter – Announced at COP28 (Dec. '23), over 50 oil and gas companies, representing 40% of global production, committed to net zero by 2050, eliminating routine flaring by 2023, and zeroing out methane emissions. National oil companies account for over 60% of signatories.

Advancing Methane Monitoring: Satellites Drive Transparency and Accountability

- Methane-Detecting Satellites – Two new satellite programs, MethaneSAT and Carbon Mapper's Tanager-1, are set to enhance global methane detection and tracking from the beginning of 2025. MethaneSAT will provide broad, high-resolution data on emissions over large areas, while Tanager-1 will focus on pinpointing and quantifying emissions at individual facilities. Together, they aim to fill critical gaps in methane monitoring, providing actionable data to help governments and industries reduce emissions. The data will be publicly available.

2 The Energy Methane Challenge

Growing Global Momentum Towards Energy Methane Mitigation

Major O&G Exporters and Importers Drive Methane Emission Reforms & Initiatives

- Waste Emissions Charge (WEC) – Starting in '24, a fee will be imposed on methane emissions from facilities in the U.S. emitting over 25,000 metric tons of CO_2e. This applies to onshore and offshore production, gas operations, and LNG facilities.
- Super Emitter Program – Part of the Environmental Protection Agency (EPA)'s new Clean Air Act rules targeting an 80% reduction in methane emissions from oil and gas operations. The program uses data from EPA-certified third-party experts with remote sensing technologies to identify large leaks. Operators must investigate, report findings to the EPA, and repair leaks. The data will be made publicly available.

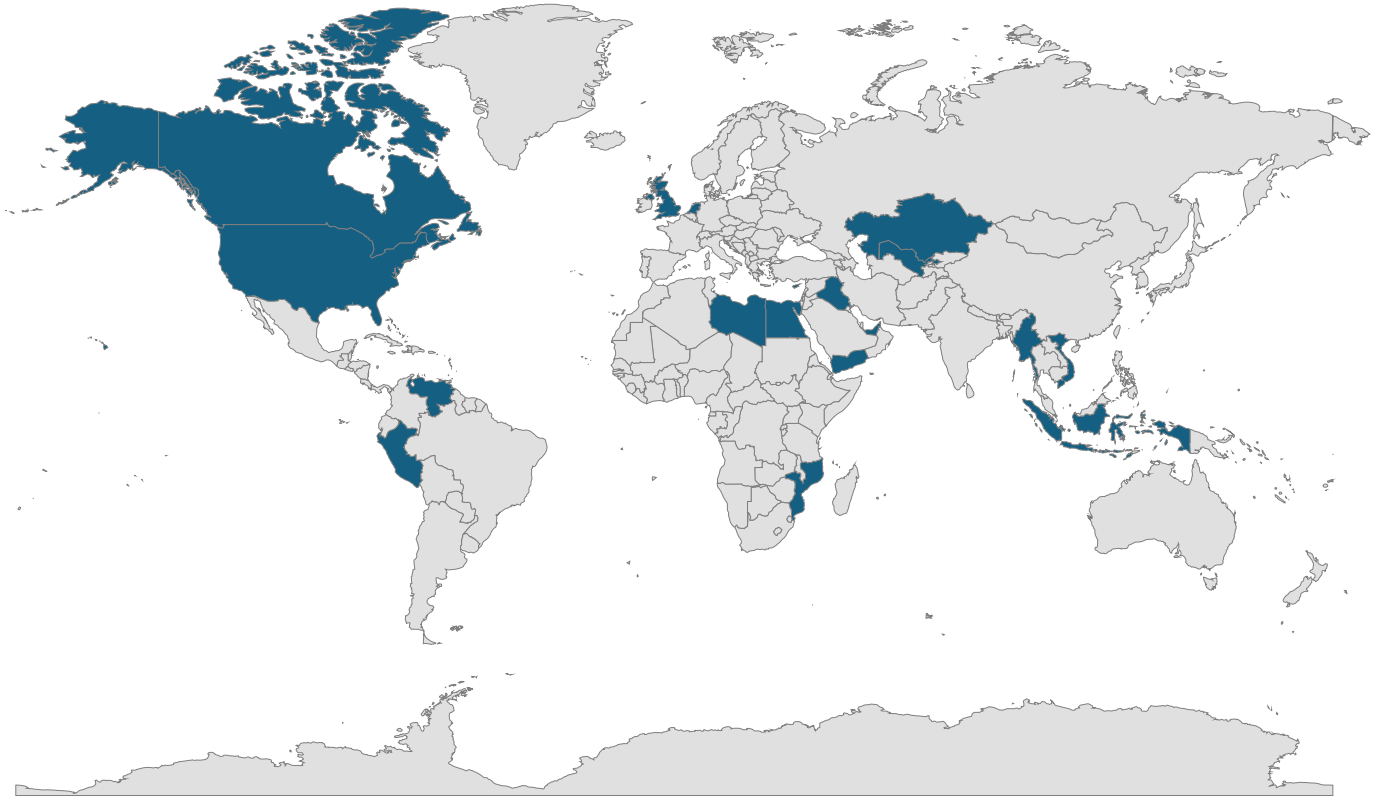
- EU Methane Import Standard – First attempt by a country/region to regulate methane emissions beyond its borders. Part of EU Methane Regulation adopted in May '24, the standard will pressure fossil fuel exporters to the EU to reduce emissions by enforcing progressively stringent MMRV requirements and imposing a maximum methane intensity value on Europe's O&G imports by '30.
- Rapid Alert Mechanism for 'Super-Emitting' Events – The EU Commission will establish a rapid alert mechanism to monitor large methane emissions from O&G facilities within and outside the EU. Based on satellite data, this mechanism will be regularly updated and made publicly available.

2 The Energy Methane Challenge

Overview: Korea's Upstream Activities

- Korea has limited domestic O&G production, with the Donghae-1 and Donghae-2 gas fields, halting production in 2021.
- Korean overseas Exploration & Production (E&P) projects span all continents, with projects by the Korea National Oil Corporation (KNOC) and the Korea Gas Corporation (KOGAS) spanning 18 countries.
- KNOC has expanded its investments across all major O&G producing regions while KOGAS, the world's largest single Liquefied Natural Gas (LNG) importer, initially focused on overseas LNG-liquefaction projects but has since expanded into E&P projects through investments in foreign natural gas companies with LNG supply.
- Major private energy companies involved in these efforts include SK Innovation E&S (Previously SK Innovation and SK E&S), POSCO International, and GS Energy.

Figure 1. 2023 | Countries with KNOC and KOGAS E&P Projects



Source: 2024 KOGAS Sustainability Report, 2024 KNOC Sustainability Report

3 Korean Upstream Methane Emissions

Overview: Upstream Methane Emissions Vs Korea's GHG Inventory

- Equity-based, upstream methane emissions from Korean assets represent nearly half of domestic energy methane emissions in Korea's National GHG Inventory (Table 1).

  Korean overseas assets produced nearly 500 thousand barrels of oil equivalent/day (approx. 486 kboe/d) on an equity basis in 2021, resulting in about 2.9 million tons CO_2e of upstream methane emissions. These emissions represent approximately 45% of domestically reported energy methane emissions.

  With global upstream GHG emissions represent roughly 5% of total O&G combustion emissions (Rystad Energy, 2023), this highlights the significant amount of methane emissions that remain unaccounted for in energy value chains involving Korean companies.

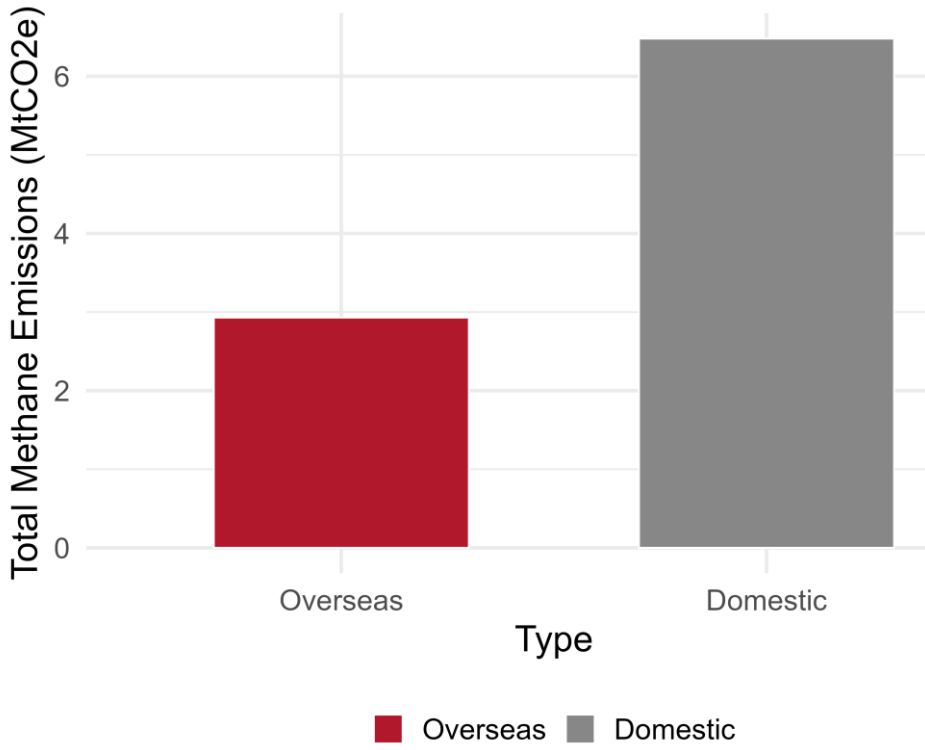
Table 1. Comparison Between Korean Upstream and Domestic Energy Methane Emissions

(Unit: Mt CO_2e)

Year	Overseas Assets Upstream Emissions	Korean Domestic Energy Emissions	Ratio of Upstream to Domestic Energy Methane Emissions
2019	3.2	6.0	53%
2020	2.5	5.9	42%
2021	2.9	6.5	45%

Source: Korean 2023 National GHG Inventory (1990-2021); Rystad Energy Upstream EmissionsCube.
Total emissions rounded to the nearest tenth.

Figure 2. 2021 | Comparison Between Korean Upstream and Domestic Energy Methane Emissions



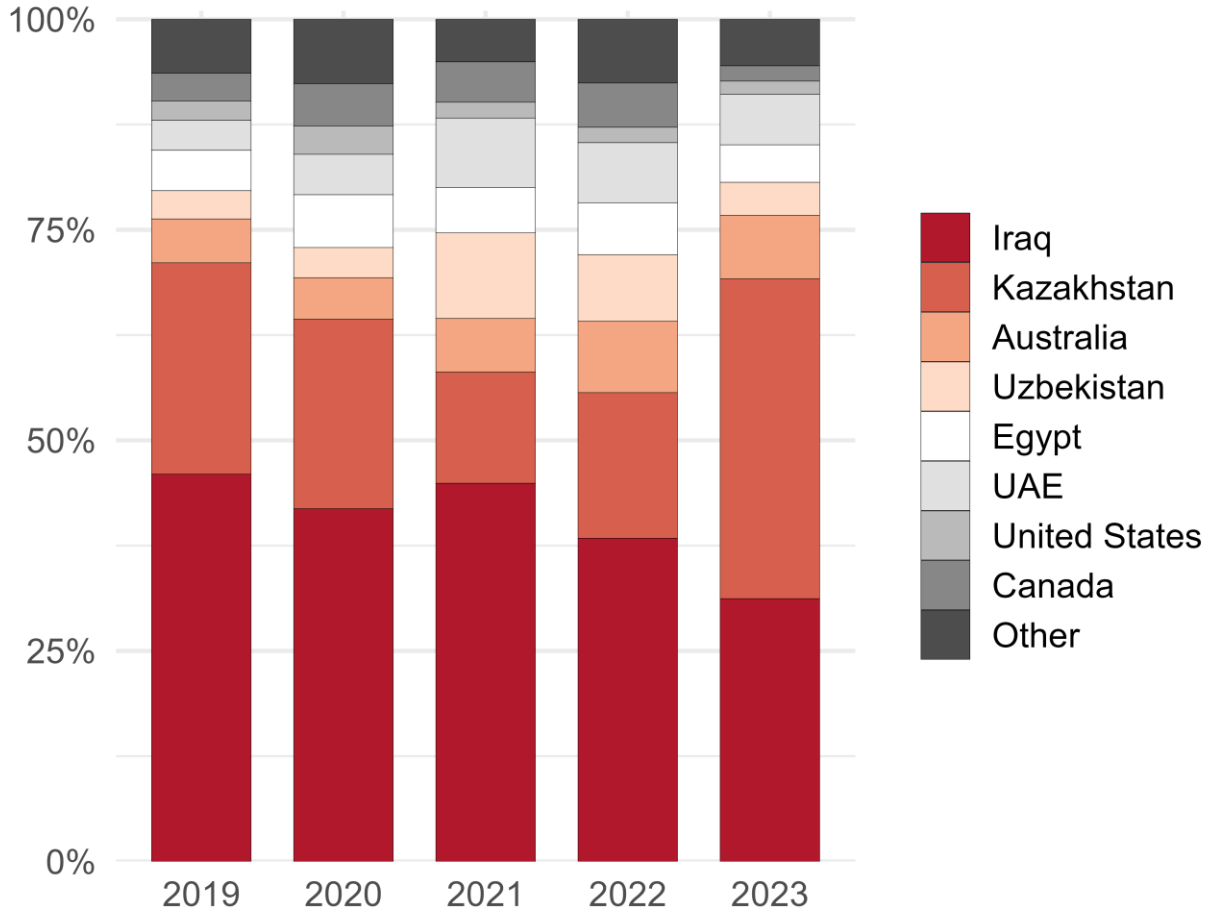
Source: Korean 2023 National GHG Inventory (1990-2021); Rystad Energy Upstream EmissionsCube.

3 Korean Upstream Methane Emissions

Overview: Countries with Most Emitting Assets

- Between 2019-2023, Korean assets in 8 countries – Iraq, Kazakhstan, Australia, Uzbekistan, Egypt, the United Arab Emirates (UAE), the United States, and Canada – accounted for approximately 92-95% of total yearly upstream methane emissions (equity-based) (Figure 3).
  - Assets in Iraq and Kazakhstan were the largest contributors, together responsible for 55%-70% of total estimated annual emissions.

Figure 3: 2019-2023 | Largest Sources of Equity-based, Upstream Methane Emissions from Korean Assets by Country



Source: Rystad Energy Upstream EmissionsCube

3 Korean Upstream Methane Emissions

Overview: Geographical Variation

- Geographical variation in upstream methane emissions (Figure 4)

  The countries with the most emitting Korean assets can be categorized based on O&G production, total emissions, and median intensity:

  High emitting-high producers – Iraq, UAE

  High intensity-low producers – Kazakhstan, Uzbekistan, Australia, and Egypt

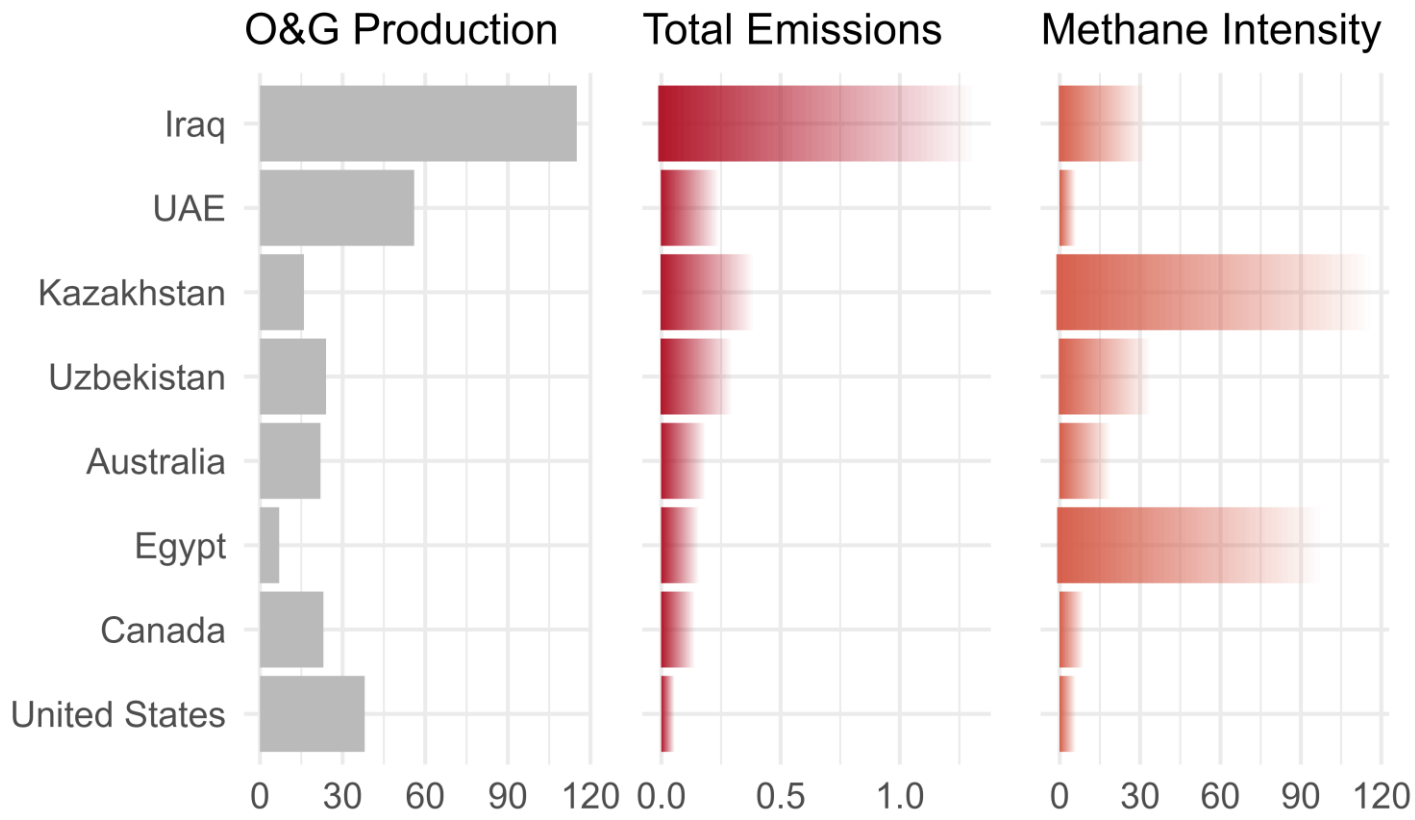
  Low emitting-high producers – Canada, United States

- Korean assets in Iraq, Kazakhstan, Uzbekistan, and Egypt produced O&G with a methane intensity above the global average

  According to Rystad Energy (2023), the global average methane intensity is about 15-20 kgco_2e per boe.

Figure 4. 2021 | Equity-based O&G Production, Upstream Methane Emissions, and Methane Intensity of Korean Assets in 8 Countries

(Unit: O&G production - kboe/d, total emissions – Mt CO_2e, methane intensity – kg



Source: Rystad Energy Upstream EmissionsCube

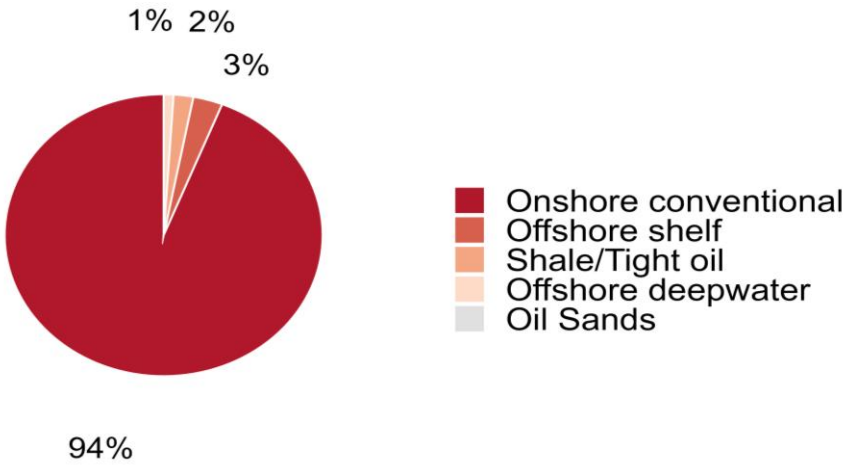
3 Korean Upstream Methane Emissions

Overview: By Segment

- By supply segment, most upstream emissions originate from conventional onshore production, accounting for approximately 94% of emissions (Figure 5).
  Conventional onshore assets produced the most O&G, around 60% of the 2021 total (296 kboe/d) and had the highest estimated median methane intensity (Figure 6).

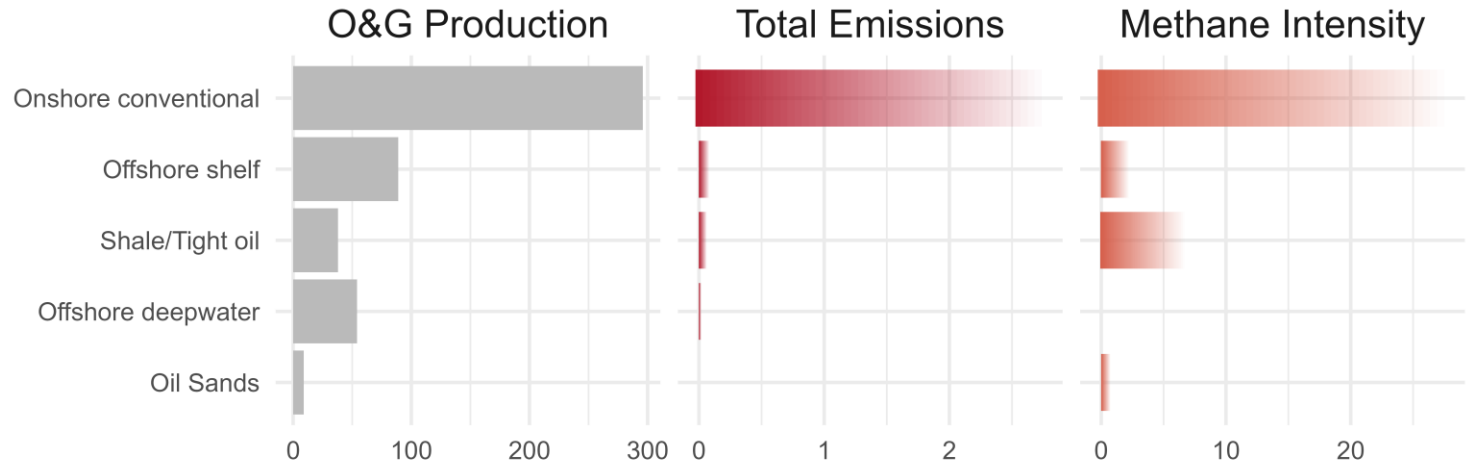
- Countries with Korean assets with the highest methane intensities – Iraq, Kazakhstan, Australia, Uzbekistan, Egypt, and the UAE – featured high-emitting conventional onshore production.
  Shale and tight oil developments registered the second highest methane intensity at about a fourth of conventional onshore production but accounted for about 8% of the 2021 total (38 kboe/d).

Figure 5. 2021 | Equity-based Upstream Methane Emissions from Korean Assets by Supply Segment



Source: Rystad Energy Upstream EmissionsCube

Figure 6. 2021 | Equity-based O&G Production, Upstream Methane Emissions, and Methane Intensity of Korean Assets by Supply Segment
(Unit: O&G production - kboe/d, total emissions – Mt CO_2e, methane intensity – kg CO_2e /boe)



Source: Rystad Energy Upstream EmissionsCube

3 Korean Upstream Methane Emissions

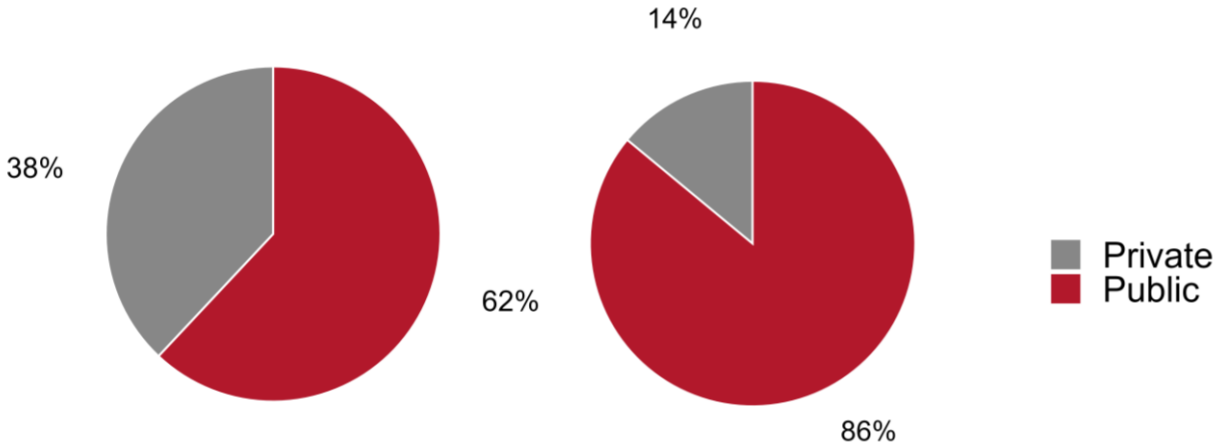
Emissions from Korean Public Companies

- Korean public companies own a significant portion of upstream assets, and consequently, produced a significant share of all equity-based methane emissions.

  In 2021, public corporations' overseas assets produced about 62%, or 300 kboe/d, of all equity-based Korean O&G, which emitted 86%, or about 2.5 Mt CO2e, of all equity-based upstream methane emissions (Figures 7 & 8).

  Table 2 shows similar production and emissions ratios for publicly held assets between 2019 and 2023.

Figures 7 & 8. 2021 | Equity-based O&G Production (Left) & Upstream Methane Emissions (Right): Public vs Private Korean Assets



Source: Adapted from Rystad Energy Upstream EmissionsCube

Table 2. 2019-2023 | Public Korean Assets Share of Equity-based O&G Production & Upstream Methane Emissions

Year	Public Production (kboe/d)	Total Production (kboe/d)	Public Production Share of Total (%)	Public Emissions ($Mt CO_2e$)	Total Emissions ($Mt CO_2e$)	Public Emissions – Share of Total (%)
2019	333	531	63%	2.8	3.2	87%
2020	301	474	64%	2.2	2.5	88%
2021	300	486	62%	2.5	2.9	86%
2022	302	491	62%	2.1	2.6	81%
2023	294	473	62%	2.2	2.6	85%

Source: Adapted from Rystad Energy Upstream EmissionsCube. Total emissions rounded to nearest tenth.

3 Korean Upstream Methane Emissions

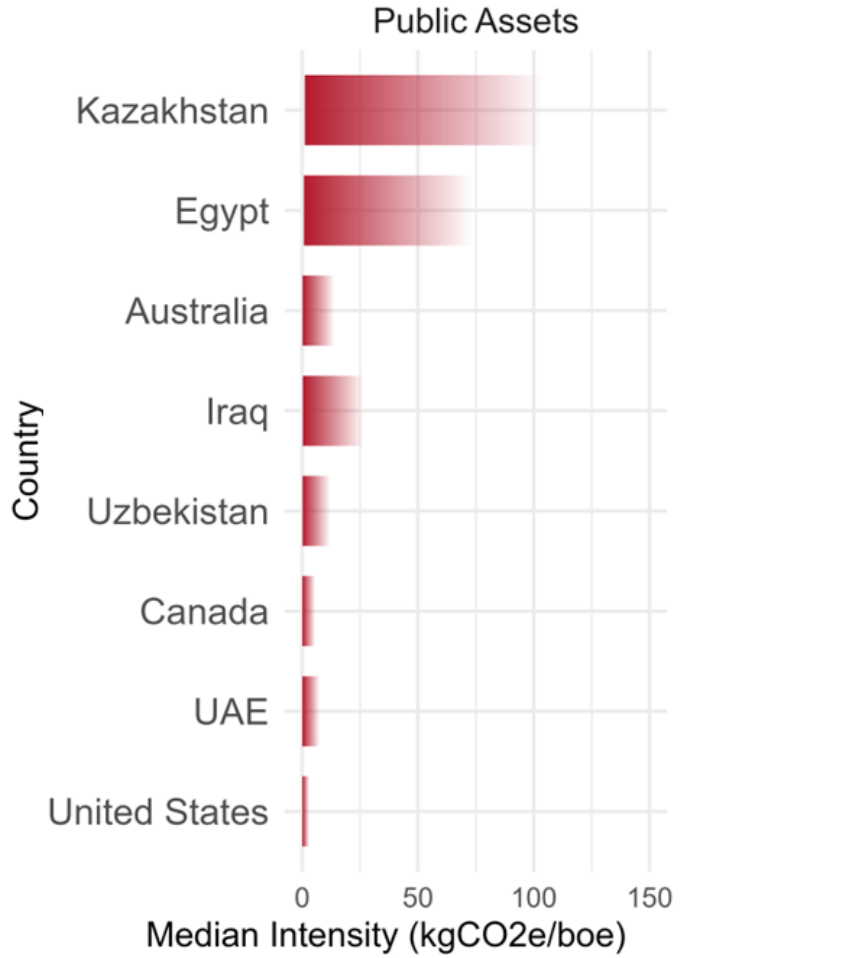
Emissions from Korean Public Companies

- Korean public companies owned some of the most methane intense assets in countries such as Kazakhstan, Egypt, and Iraq (Figure 10)

  Figure 10 compares median equity-based methane intensity of Korean public and private assets by country between 2019-2023. As with the comparison with all assets by country (figure 4), the figure shows geographic variation in methane intensity. Some countries with the most intense assets, namely Egypt and Iraq, contain only publicly owned assets.

Figure 9. 2019-2023 | Equity-based Upstream Methane Intensity of Korean Public Assets

(Unit: kg CO_2e /boe)



Source: Adapted from Rystad Energy Upstream EmissionsCube

4 Strategies for Energy Methane Mitigation

Focus Areas and Solution Pathways for Action on Methane

Barriers	Solutions Pathways
Identify scale and scope of companies' emissions	- Develop company specific methane data through local measurement campaigns, tools like MIST, and methane detecting satellites (MethaneSAT, etc.) to set up a methane inventory and drive management awareness and prioritization. - Leverage initiatives like CLEAN* to boost data collection cooperation and discuss next steps with partner companies. * Initiative by KOGAS and Japan's JERA to cut methane emissions and enhance transparency in the LNG supply chain.
Strengthen frameworks to support methane reduction work	Engage with partner companies on including methane reduction in legal, regulatory, and contractual frameworks - Discuss integrating methane management (incentivizing increased gas capture and utilization, Leak Detection and Repair (LDAR) programs, etc.) and other initiatives such as setting up GHG reduction committees into joint ventures/operations - Leverage international resources (MGP – Joint Venture Playbook)
Challenging economic incentives Economics for local methane mitigation efforts may not be favorable due to small scale of projects, low local gas prices and demand constraints	Explore financing options to support methane mitigation projects through instruments such as Article 6 of the Paris Agreement, capital markets, and discuss with relevant government ministries including the Ministry of Trade, Industry, and Energy (MOTIE) and the Ministry of Environment (ME). - Implementation of Paris Agreement Article 6.2 – Discuss with government methane mitigation projects as potential overseas reduction projects in countries with high emissions, establishing necessary bilateral agreements, etc. - Overseas Mitigation Projects – MOTIE is investing in overseas mitigation projects through direct project investments (paying a share of capital costs, reducing company burden) in exchange for Internationally Transferred Mitigation Outcomes (ITMOs), or separate contracts to purchase ITMOs. - International capital markets – Capital markets and equity investors are under increased pressure for GHG disclosure and reducing emissions within their portfolios, which can create new financing opportunities. - JP Morgan – Aims to finance efforts to reduce methane emissions in the O&G sector, setting a net zero-aligned target to lower operational (Scope 1 and 2) emissions in its financing portfolio by cutting methane leaks, venting, and flaring.

4 Conclusion

- Public companies like KNOC and KOGAS should lead by example in methane mitigation as they are responsible for a substantial portion of upstream methane emissions.
  With close ties to the Korean Government, they can play an active role in setting the direction of methane mitigation efforts. As a starting point, Korean public companies can focus on improving data quality through initiatives such as CLEAN to enable focused action and investment towards methane mitigation.

- The energy transition will require Korean companies to integrate methane emissions management into their upstream investments. If companies do not track their own methane data, the international community will do it for them.
  As global regulations tighten and methane detecting satellites increase scrutiny, O&G investments with high methane emissions increase reputational risk for Korean companies. By collaborating with producers in countries like Iraq and Kazakhstan, which recently signed the Global Methane Pledge, Korean companies can showcase their climate leadership and demonstrate their commitment to the objectives of the Paris Agreement.

Photo by Delfino Barboza on Unsplash

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Solutions for Our Climate(SFOC) is an independent policy research and advocacy group that aims to make emissions trajectories across Asia compatible with the Paris Agreement 1.5°C warming target.