Report

# Scoping Methane Emissions in ASEAN's Oil and Gas Sector

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**Authors:**
Anis Zhafran, Shania Esmeralda Manaloe, Suwanto

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ASEAN Centre for Energy
Soemantri Brodjonegoro II Building, 6th Fl.
Directorate General of Electricity
Jl. HR. Rasuna Said Block X-2, Kav. 07-08
Jakarta, 12950, Indonesia

Tel. (62-21) 527 9332 | Fax. (62-21) 527 93350
E-mail: secretariat@aseanenergy.org
www.aseanenergy.org

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This publication reflects ACE's commitment to supporting ASEAN Member States and all relevant stakeholders in better managing and mitigating methane emissions from the oil and gas sector, in line with the region's energy transition and climate goals.

# LIST OF CONTENT

**Acknowledgement** iv

**Executive Summary** vii

**INTRODUCTION** 1

**GLOBAL AND REGIONAL METHANE EMISSIONS: AN OVERVIEW** 4
- Global oil and gas methane emissions 4
- Current condition in ASEAN's oil and gas sector 5
  - Production and consumption 5
  - Exploration 8
- Regional oil and gas methane emissions 9

**REGULATORY AND POLICY FRAMEWORK** 12
- Global state of methane emission policies and regulations in the oil and gas sector 12
- Methane-related policies and regulations in ASEAN Member State 15
  - Cambodia 15
  - Indonesia 16
  - Malaysia 17
  - Thailand 17
  - Viet Nam 18
- Role of national oil and gas business entities 19
- Potential future policies 21

**METHANE EMISSION MITIGATION TECHNOLOGIES AND PRACTICES** 22
- Methane emission mitigation technologies 22
  - Detection, Measurement, and Quantification 25
  - Abatement 26
- Methane-targeted abatement technologies implemented by ASEAN's State-owned enterprises 28
  - Pertamina 28
  - Petronas 30
  - PTTEP 32

**BARRIERS AND CHALLENGES** 34
- Regulatory and Policy 36
- Economic and Financial 38
- Technology, Infrastructure, and Operational 39

**REGIONAL COOPERATION ON METHANE EMISSION IN THE ENERGY SECTOR** 40
- ASEAN Energy Sector Methane Roundtable 40
- ASEAN Energy Sector Methane Leadership Program 41
- Methane Abatement Towards a Sustainable Petroleum Industry 44
- Optimising Methane Emission Governance and Abatement in ASEAN's Oil and Gas Sector 45
- Hub for Innovative and Harmonised Methane Emission Mitigation in the ASEAN's Energy Sector 46

**RECOMMENDATIONS** 47

## LIST OF FIGURES

**Figure 1.** Methane emissions worldwide, 2023 (in $MtCO_2e$) 1
**Figure 2.** ASEAN crude oil and natural gas production, 2016-2023 6
**Figure 3.** ASEAN crude oil and natural gas production, 2015-2023 7
**Figure 4.** Southeast Asia oil and gas methane emissions by country in $KtCH_4$, 2023 9
**Figure 5.** ASEAN Oil and Gas Methane Emissions Dashboard 10
**Figure 6.** Southeast Asia oil and gas methane emissions by sector in $KtCH_4$, 2023 11
**Figure 7.** Gas flaring volume and intensity in Indonesia, 2012 – 2022 16
**Figure 8.** ASEAN state-owned enterprises participating in the Oil and Gas Methane Partnership 2.0 19
**Figure 9.** Pertamina's best practices in reducing methane emissions 29
**Figure 10.** ASEAN Energy Sector Methane Leadership Program Launching, June 2023 39
**Figure 11.** 1st Masterclass Training Introduction to Methane Emission Management, November 2023 40
**Figure 12.** 2nd Masterclass Training Policy Direction, Tools and ASEAN Experiences 40
**Figure 13.** 3rd Masterclass Training Tools for Designing and Financing Methane Mitigation Projects 41
**Figure 14.** HORIZONS framework 46

## LIST OF TABLES

**Table 1.** Classification of methane policy instruments 13
**Table 2.** Methane emission mitigation technologies by process 23

## EXECUTIVE SUMMARY


Methane, a potent greenhouse gas, has become a growing global concern due to its outsized impact on climate change. The oil and gas sector is among the largest anthropogenic sources of methane emissions, driving international commitments such as the Global Methane Pledge and the Oil and Gas Methane Partnership (OGMP) 2.0. Within ASEAN, rising production and consumption underscore the urgency to mitigate methane emissions as part of the region's broader decarbonisation goals.

This report explores methane emissions in ASEAN's oil and gas sector, assessing production and exploration activities in key countries. It provides an overview of the region's emissions landscape, drawing comparisons with global trends and highlighting gaps in monitoring and reporting. While comprehensive emissions data remain limited, early estimates suggest a need for immediate, coordinated action.

ASEAN Member States (AMS) are at different stages in developing methane-related policies. The report maps national regulations, with notable examples from Indonesia, Malaysia, Thailand, and Viet Nam, and highlights the strategic role of national oil companies (NOCs) in implementing emissions controls. While several AMS have begun addressing methane through broader energy or environmental policies, region-wide regulatory alignment is still emerging.

Technological solutions for detection, measurement, and abatement are advancing, and some NOCs—such as Pertamina, Petronas, and PTTEP—are already deploying methane-targeted innovations. These case studies showcase best practices that can inspire wider adoption across the region. Still, technical, financial, and regulatory barriers limit scalability and progress.

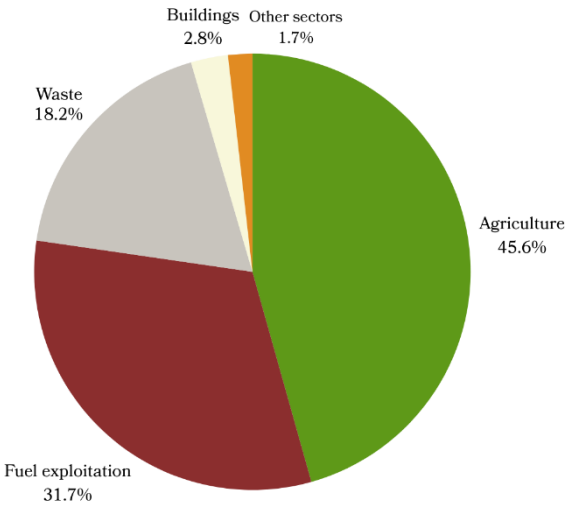
A range of barriers—policy, economic, technical—continue to limit wider methane mitigation across the region. To centralise and sustain these efforts, HORIZONS—the Hub for Innovative and Harmonised Methane Emission Mitigation in ASEAN's Energy Sector— will become the home base for all methane-related work by ACE. This includes this scoping report and future initiatives on policy advocacy, data harmonisation, research, capacity building, and financing action.

This report concludes with targeted recommendations to strengthen regional alignment, promote investment in mitigation technologies, and enhance cross-sector collaboration. Reducing methane emissions is a strategic opportunity for ASEAN to reinforce its energy security, support global climate commitments, and transition towards a more sustainable energy future.

## 1. INTRODUCTION

Methane ($CH_4$) is a short-lived climate pollutant (SLCP), representing the **second most significant greenhouse gas** driving climate change after carbon dioxide ($CO_2$). Despite its shorter atmospheric lifetime, lasting approximately a decade as compared to centuries or millennia for $CO_2$, methane's potency is striking. Over a 20-year period, methane's global warming potential (GWP) is 82.5 times greater than that of $CO_2$, and over 100 years, it retains 29.8 times the impact, according to the IPCC [1]. Methane contributes to nearly 20% of global warming observed since the pre-industrial period, highlighting the critical need to reduce emissions as part of international climate strategies [2].

**Figure 1.** Methane emissions worldwide, 2023 (in $MtCO_2e$)




Source: Authors' compilation from several sources

One of the most promising and immediate opportunities to reduce methane emissions lies in the oil and gas sector. Currently, around 32% of anthropogenic methane emissions originate from fuel exploitation as shown in Figure 1, with developing countries responsible for half of these releases [3]. Within this amount, the oil and gas sector alone contributes 25% [4].

This concentration of emissions in developing regions presents both a challenge and an opportunity. Implementing comprehensive methane mitigation measures could prevent an estimated 0.1°C of warming by mid-century, supporting efforts to meet the 1.5°C climate target [4].

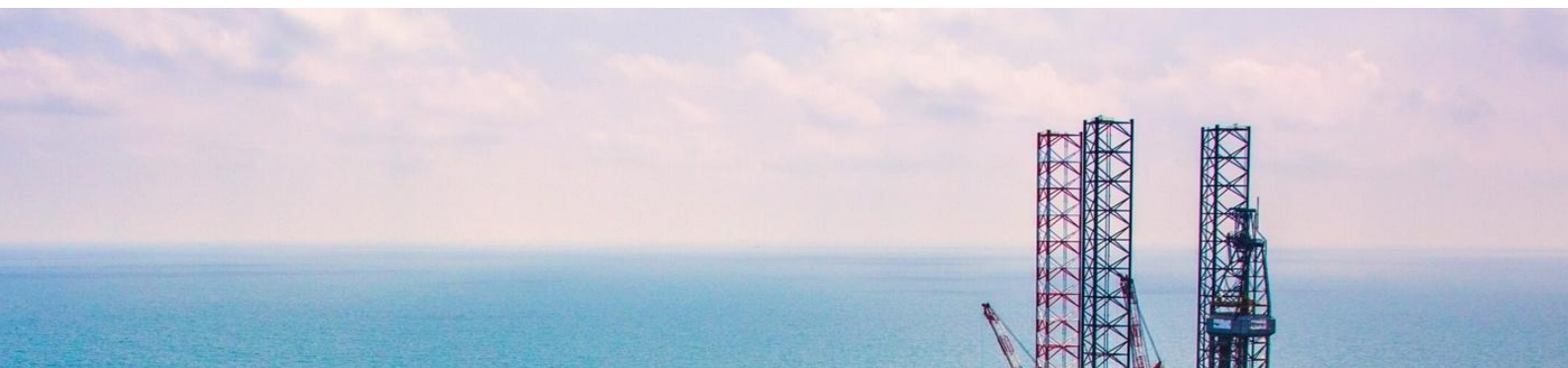
In the ASEAN region, methane emissions from oil and gas production are unlikely to decline in the near future. According to the **8th ASEAN Energy Outlook (AEO8)**, **oil and gas** accounted for **51.4%** of the region's **Total Primary Energy Supply (TPES)** in 2022, under the ASEAN Member States (AMS) Target Scenario (**ATS**). Although AEO8 projects these shares to **fall to 48.9% by 2050**, oil and gas will remain a **vital component** of ASEAN's energy mix. This underscores the importance of integrating methane reduction strategies into the region's broader energy policies [5].

Across the region, several countries and oil and gas companies have pledged to reduce methane emissions through various initiatives. One key commitment is the **Global Methane Pledge**, which aims to cut methane emissions by 30% from 2020 levels by 2030. Six ASEAN Member States—Cambodia, Indonesia, Malaysia, the Philippines, Singapore, and Viet Nam—have joined this initiative [6].

In the oil and gas sector, the **Oil & Gas Decarbonisation Charter** targets near-zero upstream methane emissions by 2030, while the **Oil & Gas Methane Partnership 2.0**, led by UNEP, seeks to enhance reporting accuracy and transparency. Notably, **Pertamina (Indonesia), PETRONAS (Malaysia), and PTTEP (Thailand)** are members of both initiatives [7], [8].


GMP
Oil And Gas Methane Partnership 2.0

While these participations and memberships are promising, they remain **largely aspirational**. Concrete, verifiable action and measurable progress toward these intended methane reduction goals **have yet to be demonstrated on a meaningful scale**.



**At this key juncture, the authors seek to highlight the current state of methane emissions in ASEAN's oil and gas sector.**

**This report, based on desktop research and interviews, presents a comprehensive analysis of existing policies, industry practices, and technological advancements**.

It also examines key challenges hindering effective methane mitigation while identifying opportunities for collaboration and improvement. By doing so, the report provides actionable recommendations for policymakers, industry leaders, and international partners to drive methane reduction efforts within supportive regulatory frameworks.

The report follows a structured approach to provide a clear and comprehensive analysis of methane emissions in ASEAN's oil and gas sector.

**Chapter 2** sets the context with an overview of global and regional methane emissions.

**Chapter 3** examines the regulatory and policy frameworks guiding methane emissions management, highlighting key initiatives and industry standards.

**Chapter 4** explores existing technologies and practices deployed to monitor, control, and reduce methane emissions, underscoring innovations that could be scaled or adapted for the region.

**Chapter 5** identifies the barriers and challenges to effective methane reduction, offering insights into the obstacles stakeholders face.

**Chapter 6** reviews regional cooperation efforts, outlining existing collaborative initiatives that support methane mitigation across ASEAN.

Finally, **Chapter 7** synthesises these findings and presents actionable recommendations for policymakers, industry leaders, and international partners to develop targeted methane reduction strategies within ASEAN's energy landscape.

# 2. GLOBAL AND REGIONAL METHANE EMISSIONS: AN OVERVIEW

## 2.1. Global oil and gas methane emissions

According to estimates from the International Energy Agency (IEA), methane emissions from fossil fuel production and use approached 120 Mt in 2023. This figure has held steady since 2019, when global methane emissions from these activities reached a record high, indicating that recent mitigation efforts have not yet brought about substantial reductions in overall emission volumes. While there are promising signs of improvement in some areas, global methane emissions remain alarmingly high, posing a critical barrier to meeting international climate targets.

Satellite data indicates that large-scale methane releases from fossil fuel operations surged by over 50% in 2023, as compared to 2022, with an estimated 5 Mt of methane attributed to major leaks worldwide [9].

Of the nearly 120 Mt of methane emissions attributed to fossil fuel use in 2023, around 80 Mt originated from the top 10 methane-emitting countries. The United States leads the world in methane emissions from oil and gas operations, closely followed by the Russian Federation. In total, methane lost through fossil fuel operations in 2023 represented approximately 170 billion cubic metres of gas. Countries with comparatively lower methane emission intensities include Norway and the Netherlands, which are recognised for effective management practices.

Similarly, countries in the Middle East, such as Saudi Arabia, maintain relatively low emission intensities within their oil and gas sectors. By contrast, nations like Turkmenistan and Venezuela exhibit some of the highest emission intensities globally, highlighting stark disparities in emission control practices across regions [9].

As previously noted, the oil and gas sector remain a major contributor to global methane emissions. Current estimates suggest that emissions from activities such as venting, leakage, and flaring within this industry account for roughly 25% of human-caused methane emissions worldwide.

*Methane release occurs through several pathways, including **intentional flaring and venting** during extraction and processing, as well as **unintentional fugitive emissions**.*

Greenhouse gas emissions, including methane from gas **flaring,** are commonly calculated based on the assumptions that flares maintain a methane destruction efficiency of 98%, with 2% of methane escaping unburned, and that flares are lit and fully operational at all times.

Based on these assumptions, the **World Bank's Global Flaring and Methane Reduction Partnership (GFMR)** estimated that in 2023, flaring activities released approximately **45 million metric tonnes of $CO_2$ equivalent ($MMtCO_2e$)** as uncombusted methane [10].

Source: Rigzone

Evidence from field research in the United States suggests that the efficiency of flaring may be far lower than anticipated, particularly in regions like the Bakken and Permian. For instance, studies have shown that 3.2% of flares in the Bakken operate unlit, directly **venting** methane into the atmosphere. Similarly, research in the Permian has found that around 5% of flares remain unlit.

Combining these findings with an observed methane destruction efficiency of only 95.2%, researchers estimate an effective destruction rate of approximately 91.1% for flares in the research sites [10]. If these rates are indicative of wider trends, the true contribution of gas flaring and venting to methane emissions could be substantially underestimated.

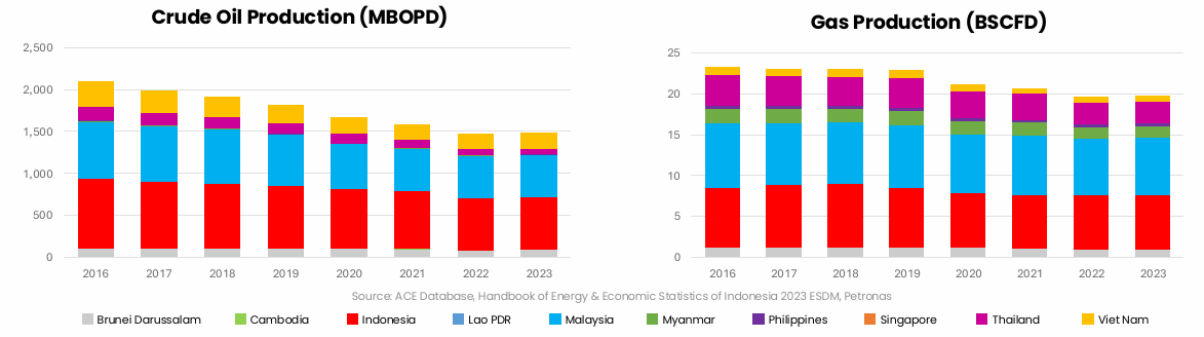
## 2.2. Current condition in ASEAN's oil and gas sector

### 2.2.1. Production and consumption

In 2023, oil production in ASEAN declined by **0.51%** compared to the previous year. Although this decrease was smaller than historical averages, it remains part of a broader trend, with an overall annual decline rate of **7.51%** in recent years (Figure 2).

This downward trend highlights the ongoing contraction of the region's output, with Indonesia and Malaysia continuing to dominate the sector, jointly producing 75.78% of ASEAN's total oil in 2023. In the same year, Indonesia experienced a 2.73% drop in production. Similarly, Thailand, another significant oil producer, saw a substantial contraction of 11%.

**Figure 2.** ASEAN crude oil and natural gas production, 2016-2023




Source: ASEAN Oil and Gas Updates, 2024

Natural gas production faced consistent declines from 2016 to 2022, averaging **a 3.02% annual decrease**. However, in 2023, production saw a slight **increase of 0.84%**. Unlike previous years, the region's top three gas producers—**Indonesia, Malaysia, and Thailand**—experienced modest growth in output [11].

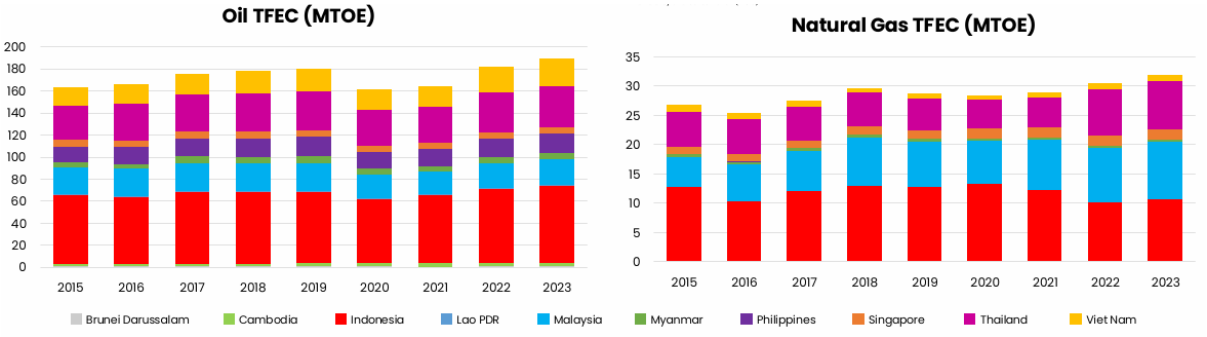
The decline in oil and gas output across the region—despite a slight increase in gas production—is primarily driven by the depletion of major fields. To counter this trend, advanced techniques such as **workover procedures** and **enhanced oil and gas recovery (EOR/EGR)** have become essential.

**While rising oil and gas prices have renewed interest in optimising production, fully revitalising these mature fields remains a significant challenge.**

In 2023, **ASEAN's crude oil consumption** increased by **4.19%** compared to the previous year, driven by recovering economic activity following the 2020–2021 pandemic-induced recession (Figure 3).

Natural gas consumption, which had seen slight declines in previous years, experienced a notable rebound, rising **4.56%** from 2022 levels. This growth outpaced the increase in oil consumption, signalling a shift in regional energy demand. **Indonesia** and **Malaysia** recorded the highest growth in natural gas consumption, at **5.51%** and **5.09%**, respectively, reflecting their expanding industrial and domestic energy needs.

**Figure 3.** ASEAN crude oil and natural gas consumption, 2015-2023




Source: ASEAN Oil and Gas Updates, 2024

These rising energy demands align with ASEAN's broader economic trajectory, as the region's **GDP grew by 4.07% in 2023** [11].

Looking ahead, ASEAN's energy landscape reflects a balance between continuity and transition, as the region navigates economic growth while shifting towards alternative energy sources. The compound annual growth rate (CAGR) for oil and gas **Total Primary Energy Supply (TPES)** is projected to **decline to 0.45% by 2050**, down from the **2022–2030 forecast**.

Meanwhile, **ASEAN's Total Final Energy Consumption (TFEC) for oil and gas** is projected to grow at a CAGR of **2.2% from 2022 to 2030**, before slightly slowing to **1.9% by 2050** [5].

This growth reflects the region's **economic expansion** and **evolving energy demands**, though the pace is expected to moderate as **cleaner and more diverse energy sources** are increasingly integrated into the energy mix.

Importantly, methane emissions from the oil and gas sector are expected to decrease over the long term. However, addressing the current state of emissions is critical to ensuring that near-term challenges do not hinder broader transition efforts.

Together, **these trends highlight ASEAN's evolving energy dynamics** as it seeks to balance demand with sustainable development goals.

### 2.2.2. Exploration

Despite the widening gap between production and consumption in the region, several ASEAN countries are expanding **exploration efforts** to sustain natural gas production. **Malaysia** is targeting **stranded high-carbon dioxide gas fields** to support long-term output, while **Indonesia** is also increasing its exploration activities [12].

Meanwhile, **Thailand and Cambodia** are collaborating on **joint exploration in the Gulf of Thailand**, and the **Philippines** has extended contracts for its **Malampaya gas field** [13], [14]. **Viet Nam** has also progressed with its **Block B Project**, which includes an **upstream gas field** and a pipeline supplying a **gas-fired thermal power plant** [15].

These developments reflect a broader regional trend, with **fossil fuels projected to account for 86.4% of ASEAN's total energy mix by 2025** [16].

Malaysia's oil and gas sector is undergoing a transformation, with increased focus on exploration. Significant investments, such as TotalEnergies acquiring a stake in SapuraOMV and Chevron's acquisition of Hess assets, underscore confidence in Malaysia's energy future.

PETRONAS is leading this resurgence with the Malaysia Bid Round 2024 (MBR 2024), introducing new exploration blocks and Discovered Resource Opportunities (DRO) [17]. This initiative aims to strengthen Malaysia's position as a prime energy investment destination, aligning with national objectives to secure energy supply and stimulate economic growth.

Indonesia is also working to enhance the attractiveness of its **oil and gas sector** through **strategic initiatives** and **recent discoveries**. By **mid-2024**, the country plans to **offer new exploration blocks** in the **North Sumatra Basin**, with a focus on **unconventional resources**.

State-owned oil company **Pertamina** is making significant progress on its **Balikpapan Refinery Development Master Plan (RDMP)**—one of the largest projects in its history. By **2023**, the project was **82% complete**, aiming to increase the refinery's processing capacity to **360 KBPD** [11], [17].

These efforts, bolstered by **successful bidding rounds** and **regulatory reforms**, are key to **Indonesia's strategy** of balancing **energy production, economic growth, and environmental sustainability**.

## 2.3. Regional oil and gas methane emissions

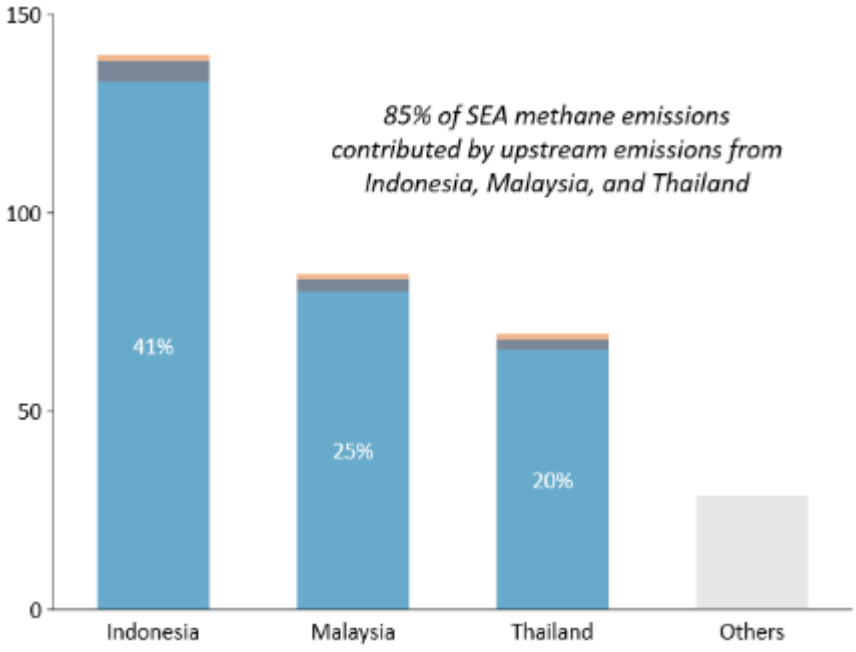
The authors rely on the **ASEAN Oil and Gas Methane Emissions Dashboard (2023)**, which estimates methane ($CH_4$) emissions at identified hotspots using calculated **emission factors**. This dashboard provides a comprehensive view of $CH_4$ emissions across Southeast Asia, specifically from **oil and gas sector activities**.

Data from the dashboard indicate that **322 kilotonnes (kt) of methane emissions** were recorded across **379 oil and gas sites** in the region [18]. This substantial volume underscores the **significant contribution** of the oil and gas sector to regional methane emissions.

**Southeast Asia**, methane emissions from **oil and gas operations** remain significant, with **2023 emissions** reaching approximately **0.32 megatonnes (Mt)**—equivalent to **9 $MtCO_2$** in **global warming potential (GWP)**.

This methane loss also represents an **economic setback**, amounting to roughly **0.5 billion cubic metres of gas**, or about **7% of Singapore's liquefied natural gas (LNG) imports** for the same year.

**Figure 4.** Southeast Asia oil and gas methane emissions by country in $ktCH_4$, 2023




Source: MAESTRO Dashboard (ACE), 2024

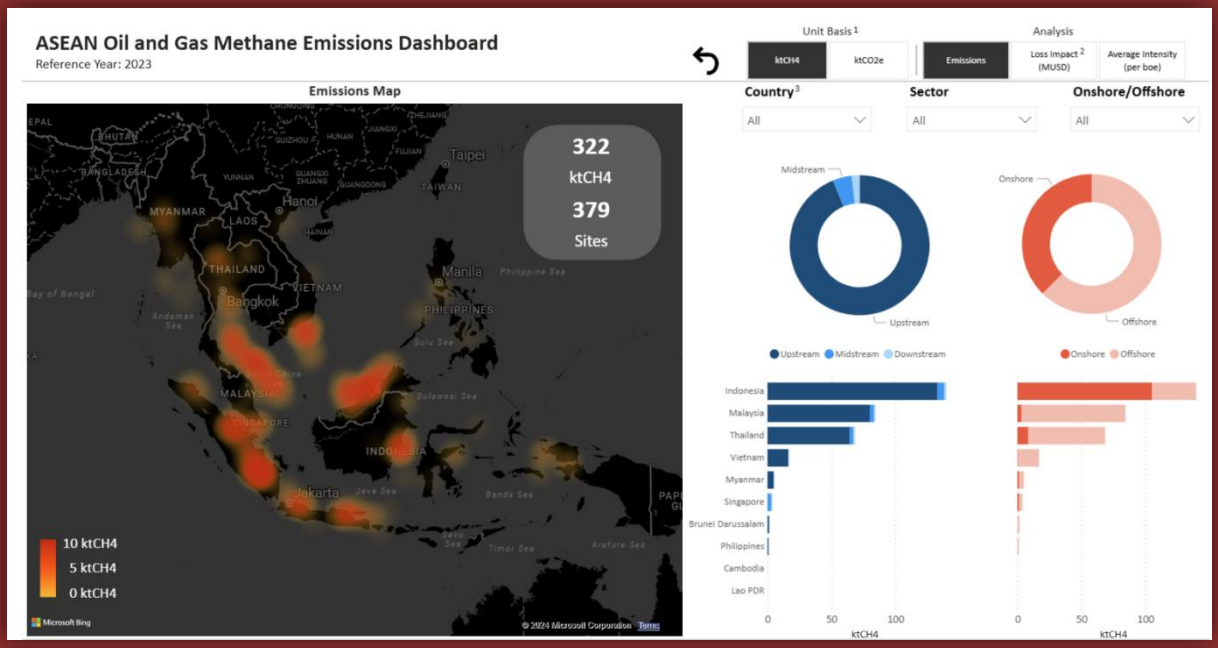
As shown in Figure 4, **Indonesia, Malaysia, and Thailand**—ASEAN's top oil and gas producers—account for **85% of the region's total methane emissions** [18]. **Indonesia** leads with **41%**, followed by **Malaysia (25%)** and **Thailand (20%)**. This

concentration highlights the urgent need for **targeted mitigation efforts**, particularly in the **upstream sector**, to achieve meaningful reductions in regional methane emissions.

A closer examination of the **geographical distribution** reveals several prominent **methane emission hotspots** across the region, represented by **orange to red-shaded areas**. These hotspots indicate regions with **elevated methane emissions**, typically where **oil and gas activities** are most concentrated.

As shown in Figure 5, **approximately 25%** of emissions originate from **onshore sources**, while the remaining **75%** come from **offshore activities**. This distribution underscores the **significant methane output** from offshore extraction, particularly in countries with **extensive offshore oil and gas production**, such as **Malaysia**.

**Figure 5.** ASEAN Oil and Gas Methane Emissions (MAESTRO) Dashboard



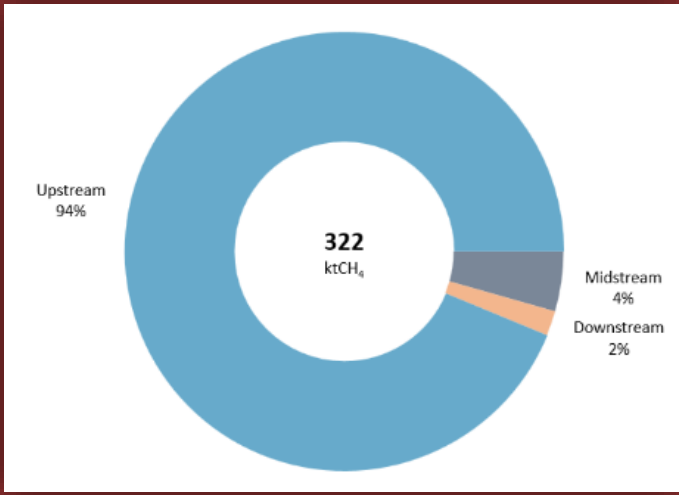

Source: ASEAN Centre for Energy (ACE), 2024

The data highlight several **intense methane emission zones**, with **Indonesia** leading at **140 ktCH$_4$**, particularly around **Java, Sumatra, and Kalimantan**. **Sumatra** stands out due to its **extensive onshore oil production**, reinforcing findings that **onshore activities** are a major source of methane emissions in the country.

**Malaysia** also exhibits **concentrated emissions**, notably in **Peninsular Malaysia, Sarawak, and Sabah**, with a total of **85 ktCH$_4$**. These areas host **significant offshore oil and gas operations**, which contribute heavily to the nation's methane emissions.

Similarly, **Thailand** records **69 ktCH$_4$** in the **Gulf of Thailand**, directly linked to its **offshore oil and gas activities**. Meanwhile, **Viet Nam and Myanmar** show smaller methane hotspots along their coastlines, with **17 ktCH$_4$ and 5 ktCH$_4$**, respectively. These figures suggest emissions from **smaller-scale or emerging oil and gas industries** in these countries.

**Figure 6.** Southeast Asia oil and gas methane emissions by sector in ktCH$_4$, 2023




Source: MAESTRO Dashboard (ACE), 2024

In terms of **sectoral contributions**, the **upstream sector**—which includes **extraction and production**—is responsible for **94% of methane emissions**, as shown in Figure 6.

The **midstream sector**, which covers **transportation and storage**, accounts for **4%**, while the **downstream sector**, involving **refining and distribution**, contributes just **2%**.

This distribution highlights that **upstream activities**, particularly those involving **venting, flaring, and fugitive emissions**, are the **dominant source** of methane emissions in Southeast Asia's oil and gas industry.

# 3. REGULATORY AND POLICY FRAMEWORKS

## 3.1. Global state of methane emission policies and regulations in the oil and gas sector

In recent years, methane regulation in the energy sector has become increasingly prevalent, particularly in the oil and gas industries, as countries worldwide work to address this potent greenhouse gas. Policies targeting methane emissions often centre around flaring and venting—the processes of burning or directly releasing methane from oil and gas operations.

However, approaches to regulating these emissions vary significantly across jurisdictions, reflecting the unique economic, environmental, and industrial contexts of each region.

A **historical analysis** of methane policies shows a **gradual increase** in regulatory efforts since the **1970s**, with a **notable peak in 2018**. This surge coincides with the **2016 North American Leaders' Summit**, where **Canada, Mexico, and the United States** committed to cutting **methane emissions** from their **oil and gas sectors** by **40%–45% by 2025** (relative to 2012 levels) [19].

Their **ambitious targets** and the subsequent adoption of **methane regulations** influenced other **Group of 20 (G20) nations**, driving a broader **global push** for **stricter methane controls** within the **oil and gas industry**.

An emerging trend among some regulatory frameworks, as listed in Table 1, is the integration of flaring and venting controls with requirements for operators to proactively address methane leaks.[1] Such provisions typically mandate the implementation of regular leak detection and repair (LDAR) programmes, obligating operators to identify and remediate methane leaks throughout their operations.

This shift reflects an increasing emphasis on preventing fugitive emissions and underscores the role of advancing methane detection technology in shaping policy. As monitoring and quantification technologies have improved over the last decade, LDAR requirements have gained traction as an effective regulatory tool, allowing for more accurate identification of emission sources.

[1] For instance, Brazil's National Agency of Petroleum, Natural Gas, and Biofuels (ANP) issued Resolution 806/2020, setting out specific procedures to control and reduce gas flaring and wastage during oil and gas exploration and production.

**Table 1.** Classification of methane policy instruments

| Instrument | Policy & Regulation |
|---|---|
| **Regulatory** | 1. **Flaring and venting regulations**<br>2. **LDAR regulations**<br>3. Coalbed methane (CBM) ownership and utilisation<br>4. Coal mine methane (CMM) capture<br>5. **Recovery and utilisation**<br>6. Ventilation air methane (VAM) regulations<br>7. **Facility abandonment** |
| **Economic** | 1. Emissions Trading System (ETS)<br>2. Offset credits<br>3. Taxes and charges<br>4. Fiscal and financial incentives<br>5. Incentives for price-regulated entities |
| **Information** | 1. Measurement, reporting, and verification (MRV)<br>2. Technical guidance<br>3. Certification system<br>4. Awareness-raising measures |
| **Complementary** | 1. Voluntary programmes<br>2. Research and development (R&D)<br>3. Subsidies<br>4. Green public procurement |

Source: Olczak et al., 2023
Bolded instruments directly related to the oil and gas sector.

Some **jurisdictions** have introduced **comprehensive programmes** focused on **post-operation activities**, specifically targeting **methane emissions** from **inactive or abandoned sites**. For example, **Colorado's Orphaned Well Programme**, funded by **oil and gas operators**, aims to **mitigate emissions** from **abandoned wells** [19].

Such initiatives highlight the **potential of targeted remediation efforts** within **methane regulations** and reinforce the **industry's responsibility** to manage its **environmental footprint** beyond **active operations**.

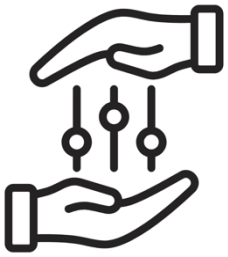
Beyond **regulatory measures**, many countries support methane mitigation through **economic and informational instruments**, including **voluntary** programmes.[2] These initiatives often involve **agreements** between **government bodies** and **industry sectors**, where **companies commit** to meeting **specific environmental targets**.

In addition to national efforts, methane mitigation requires greater attention at regional and global levels. A recent study highlighted the importance of new regional and national policies to unlock methane reduction opportunities in Russia, Central Asia, the Middle East, Africa, Central and South America, and parts of the Asia-Pacific region. These regions collectively contribute around 80% of global methane emissions, largely due to the prevalence of fossil fuel production.

In contrast, **North America** and **Europe** produce only **30% of global oil and gas** and **13% of coal**, yet they have more comprehensive methane policies.

Furthermore, the faster economic growth projected in many emerging economies—3.7% in 2023 compared to 1.1% in advanced economies—suggests a rising demand for fossil fuels, which could drive higher methane emissions unless stringent regulations are implemented [19].

Methane emissions from oil and gas operations pose **distinct regulatory challenges** due to their **dispersed and varied nature** across the **supply chain**. Unlike **coal mining**, where emissions are typically **concentrated** at a **limited number of sites**, the **oil and gas sector** encompass **upstream, midstream, and downstream activities**, each potentially subject to different regulatory frameworks.



The **sector's diversity**—spanning **regulated utilities** to **independent operators**—requires **tailored policy approaches**. With **numerous wells, pipelines, and facilities** spread across **vast areas**, emissions sources are **more difficult to monitor and control**. This **spatial complexity** demands **stricter** and **more sophisticated regulatory frameworks** to ensure comprehensive oversight and effective mitigation.

[2] A prominent example is found in the Netherlands, where offshore oil and gas producers, represented by the Netherlands Oil and Gas Exploration and Production Association (NOGEPA), pledged to halve methane emissions between 2019 and 2020. This commitment, formalised through a covenant signed by the Minister of Economic Affairs and Climate Policy, surpassed its target, reporting a 57% reduction in methane emissions by April 2021.

## 3.2. Methane-related policies and regulations in ASEAN Member States

This sub-chapter focuses on five ASEAN Member States—**Cambodia, Indonesia, Malaysia, Thailand, and Viet Nam**—as they are the only countries in the region that have developed or are in the process of developing **methane-related policies and regulations**.

By examining these nations, the report provides a **detailed exploration** of **existing frameworks** and their **implementation**, offering valuable insights into how methane emissions are currently being addressed. This focus highlights **visible best practices**, serving as a **foundation** for other ASEAN Member States as they develop their own policies.

Additionally, this approach underscores the **urgent need** to expand methane mitigation efforts **region-wide**, ensuring a **cohesive and effective response** to emissions challenges across ASEAN.

### 3.2.1. Cambodia

Cambodia is advancing methane reduction efforts through a **National Methane Roadmap**, developed with support from the Institute for Global Environmental Strategies Centre Collaborating with UNEP on Environmental Technologies (IGES-CCET) and the Climate and Clean Air Coalition (CCAC).

This Roadmap aims to prioritise methane mitigation strategies that align with the Global Methane Pledge's goal of limiting warming to 1.5°C.

On 10 May 2023, an inception meeting was held to gather key stakeholders, including national government officials, the GHG Inventory sub-working group, academics, and sector experts. The meeting reviewed Cambodia's methane emissions landscape, discussed data availability, and assessed existing policies, setting the groundwork for road map activities. Key outcomes included an agreed-upon timeline, consensus on project monitoring, and strengthened administrative and political support for effective implementation [20].

### 3.2.2. Indonesia

In Indonesia, gas flaring in the oil and gas sector is regulated under **Minister of Energy and Mineral Resources (MEMR) Regulation No. 17 of 2021**, which establishes **guidelines to mitigate environmental impacts**.

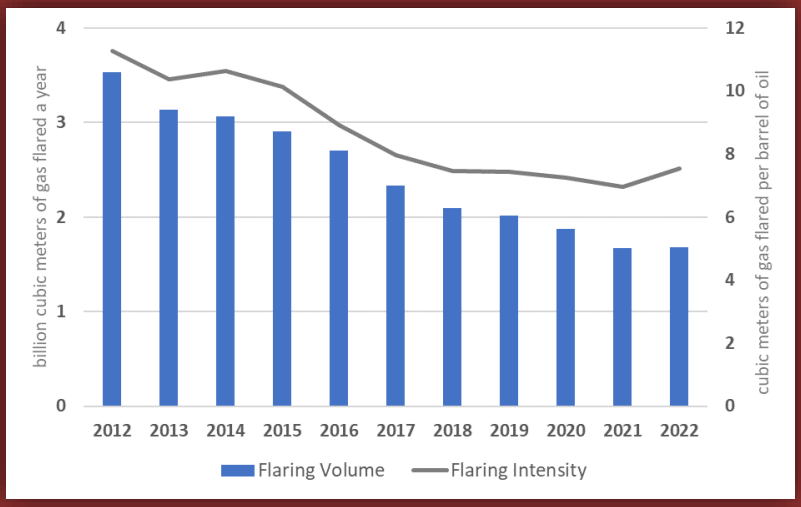
Under this regulation, contractors may flare gas **only under specific conditions**:

- For **natural gas fields**, flaring must **not** exceed **2% of the daily volumetric flow rate** of feed gas per field.
- For **petroleum fields**, flaring is limited to an average of **2 million standard cubic feet per day (MMSCFD)** over a **six-month period**.

Additionally, **new oil and gas refineries** must be **designed to eliminate routine gas flaring**, reinforcing Indonesia's commitment to **reducing methane emissions** in the sector.

The regulation also prohibits business entities with processing permits from engaging in routine gas flaring. Any flaring event lasting more than one day, with an average daily volume exceeding 20 MMSCFD, must be reported to the Head of Inspection within 24 hours. Non-compliance with these regulations can result in administrative sanctions, such as written warnings, dismissal of engineering heads, or temporary suspension of operational activities at production facilities.

**Figure 7.** Gas flaring volume and intensity in Indonesia, 2012 – 2022




Source: Global Flaring and Methane Reduction (GFMR), World Bank, 2023

The impact of these regulations is significant. The volume of gas flared in Indonesia has dropped markedly, from 3.5 billion cubic metres in 2012, to 1.7 billion cubic metres in 2022, as shown in Figure 7 [21].

This reduction is more substantial compared to the nearly 30% decline in oil production over the same period. Although the overall trend in flaring intensity has been declining, there was a slight uptick in 2022. As of the latest survey, there were 189 identified flare sites.

Indonesia has updated its NDC targets, aiming to cut emissions by 31.89% unconditionally and up to 43.2% with international support by 2030. In the oil and gas sector, the country is prioritising methane reduction through energy efficiency improvements, CCS initiatives, and gas flaring optimisation. The government remains committed to achieving net zero emissions by 2060 or sooner.

### 3.2.3. Malaysia

Sarawak has taken a significant step towards environmental stewardship and greenhouse gas (GHG) mitigation with the introduction of the ***Environment (Reduction of Greenhouse Gases Emissions) Ordinance, 2023***. This legislation establishes a comprehensive framework for managing carbon emissions within the oil and gas sector, setting clear regulatory requirements and incentives to drive emissions reductions.

**Article 10** of the ordinance specifically governs the **flaring and venting** of petroleum and greenhouse gases. Under this provision, **no flaring or venting may take place without prior written approval from the Controller**. In cases of **non-compliance**, the Controller is authorised to issue a Stop Order, requiring an **immediate halt** to such activities. If the order is **ignored**, enforcement measures may include **direct intervention to cease operations** or seeking a **High Court Order to mandate compliance**, accompanied by a **financial penalty** of no less than **five hundred thousand ringgits**. Continued non-compliance with a court order may result in contempt of court proceedings, allowing the Controller to apply for an Order of Committal against the offending party.

This ordinance underscores Sarawak's commitment to stringent environmental regulations, with a strong focus on reducing GHG emissions, particularly methane, and promoting sustainable practices in the oil and gas industry. By mandating strict reporting requirements, encouraging voluntary emission reduction efforts, and enforcing rigorous controls on flaring and venting, Sarawak is taking a proactive role in combating climate change and strengthening environmental protection.

### 3.2.4. Thailand

Methane emission reduction policies in Thailand are aligned with the country's Nationally Determined Contributions (NDC) under the Paris Agreement, as Thailand is not yet a member of the Global Methane Pledge. Key regulation include the **Notification from the Ministry of Natural Resources and Environment,** which sets **standards for vapour emissions from bulk gasoline terminals**.[3] According to this notification, the **total Volatile Organic Compounds (VOCs), including methane, must not exceed 17 milligrams per litre** of emitted vapour per hour during gasoline transfer from tank trucks.

Additionally, the Notification from the Department of Mineral Fuels requires concessionaires, production sharing contractors, and service contractors in

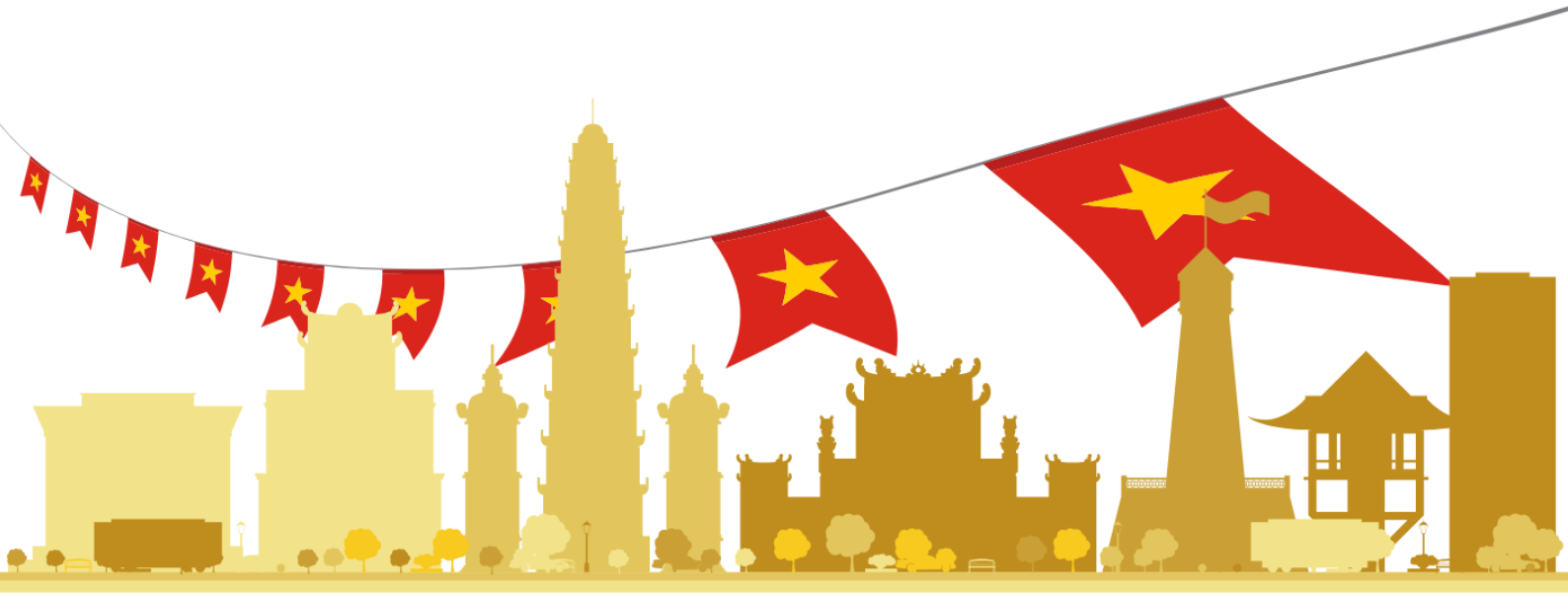
[3] Notification of the Ministry of Natural Resources and Environment on the Emission Standard of Vapour From a Bulk Gasoline Terminal B.E.2564 (2021).

the oil and gas sector to report their scope 1 and 2 greenhouse gas emissions on an annual basis.[4] Petroleum companies, including major players like PTTEP, are responsible for tracking and reporting methane emissions, which includes **measuring fugitive, vented, and flared emissions**. Monitoring is conducted through continuous sampling or multiple sampling events per hour to ensure accurate emission calculations.

### 3.2.5. Viet Nam

Viet Nam is notable among ASEAN countries for its specific targets and action plans aimed at reducing methane emissions. **Decision No. 942/QD-TTg** outlines the country's commitment to **reducing methane emissions by at least 30% below 2020 levels by 2030**. The plan sets specific targets for methane emissions, including **8.1 metric tonnes from oil and gas extraction**, **2.0 metric tonnes from coal mining**, and **0.8 metric tonnes from fossil fuel consumption**.

The action plan also delineates several tasks for the government, such as **developing and updating regulations and policies to mitigate methane emissions**, **implementing measures to reduce emissions from various sources**, **enhancing research and development**, **promoting information dissemination and capacity building**, **strengthening international cooperation**, and **ensuring accurate measurement, reporting, and verification** of emission reductions.



[4] Notification of the Department of Mineral Fuels regarding Criteria on Reporting and Calculation Methods of the Greenhouse Gas Emissions from Petroleum Business Operation B.E. 2565 (2022).

### 3.3. Role of national oil and gas business entities

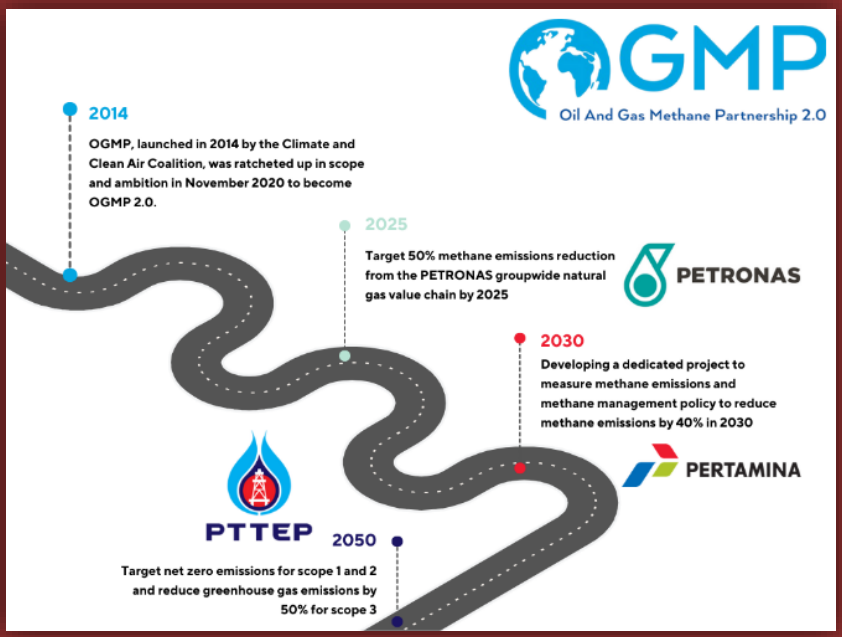
In the quest to mitigate climate change impacts and work side-by-side with its respective governments, leading oil and gas companies in the ASEAN region are making significant strides in reducing methane emissions, setting ambitious targets, and implementing advanced technologies. Among these, Petronas, Pertamina, and PTTEP stand out for their proactive approaches to emission reductions.

**Petronas**, a leading energy company based in Malaysia, has committed to significantly reducing methane emissions across its operations. The company aims to achieve a **50% reduction in methane emissions from its natural gas value chain by 2025** (Figure 8) [22], underscoring its dedication to mitigating methane's environmental impact.

To achieve this target, Petronas is implementing several high-impact initiatives, including flagship methane abatement projects. These efforts involve **comprehensive methane quantification surveys**, the **elimination of routine gas flaring**, and **collaborations on innovative solutions**.

Notably, Petronas is working with experts to oversee measurement, monitoring, reporting, and verification (MMRV) processes, as well as leading research and development initiatives in partnership with the Japan Oil, Gas and Metals National Corporation (JOGMEC) under the Southeast Asia Methane Emissions Technology Evaluation Centre (METEC). These initiatives reflect the company's commitment to reducing its methane footprint while contributing to broader industry advancements.

**Figure 8.** ASEAN state-owned enterprises participating in the Oil and Gas Methane Partnership 2.0




Source: Oil and Gas Methane Partnership 2.0 (OGMP 2.0)

Meanwhile, Pertamina, **Indonesia's state-owned energy company**, has set its own ambitious targets, aiming for a **40% reduction in methane emissions by 2030** (Figure 8) [23]. To support this objective, Pertamina launched a dedicated project in 2023 to measure methane emissions and establish a methane management policy.

**Initial measurements** were conducted across **upstream** and **downstream** operations in Kalimantan, with the initiative continuing in 2024 to quantify methane emissions and calculate carbon intensity from its upstream operations. In collaboration with JOGMEC, Pertamina is conducting an in-depth analysis of methane emissions measurement and quantification from upstream activities. The project also focuses on identifying key mitigation actions at the **Donggi-Matindok Field** and the **JOB Tomori Field**, further reinforcing its commitment to sustainable energy practices.

**PTTEP** in Thailand has also outlined an ambitious strategy for emission reductions. The company is targeting net-zero emissions for its Scope 1 and 2 emissions, and aims to **cut greenhouse gas emissions by 50% in Scope 3 by 2050** (Figure 9) [25]. To achieve these targets, PTTEP has implemented a comprehensive **Direct Inspection and Maintenance (DI&M) programme**. This programme includes the deployment of advanced equipment, such as infrared cameras and acoustic detectors, to identify and assess methane leaks.

These technologies are integral to PTTEP's strategy to effectively monitor and reduce methane emissions, demonstrating the company's commitment to leveraging innovation in its environmental efforts.

### 3.4. Potential future policies

At the **42nd ASEAN Ministers on Energy Meeting (AMEM) held in September 2024**, the **Joint Ministerial Statement** highlighted the region's growing commitment to **addressing methane emissions in the energy sector**. The ministers **welcomed** initiatives such as the completion of the **ASEAN Energy Sector Methane Leadership Programme (MLP) 1.0**, and the **commencement of MLP 2.0**.

These initiatives are organised under the **USAID Southeast Asia Smart Power Programme (SPP)** in collaboration with the **ASEAN Centre for Energy (ACE)** and the **ASEAN Council on Petroleum (ASCOPE)** [26]. Their continuation reflects the importance of enhancing capacity and regional cooperation in methane management.

Additionally, the meeting acknowledged the proposed inclusion of methane emission mitigation as a strategic direction in the forthcoming **ASEAN Plan of Action for Energy Cooperation (APAEC)** document.

The **APAEC** is a **strategic framework** that fosters energy cooperation and integration among the AMS, promoting **energy security**, **sustainability**, and **transition**. Phase II of APAEC, covering 2021–2025, is set to conclude this year, marking significant progress in regional energy initiatives. Discussions are already underway to shape the post-2025 cooperation document, aiming to build upon past achievements and address emerging challenges in the energy landscape.

Including methane abatement in APAEC post-2025 is vital, due to methane's significant contribution to the region's energy-related greenhouse gas emissions. Addressing methane aligns with global climate goals, including the **Paris Agreement** and **Global Methane Pledge**, by accelerating energy transition while strengthening regional energy security.

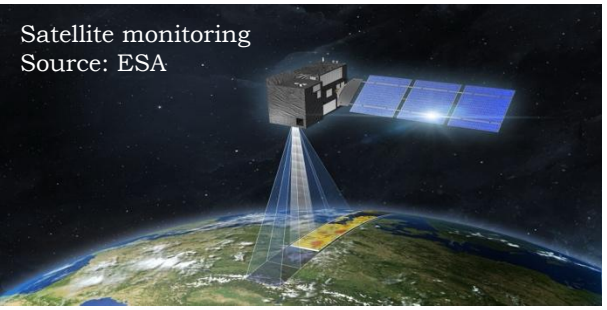
Furthermore, with the AEO8 projecting a tripling of energy demand by 2050, dominated by fossil fuels, mitigating methane emissions becomes crucial to counteract the environmental and climate impacts of this growth.

This recognition highlights the increasing prioritisation of methane abatement as part of ASEAN's broader energy transition goals. The directive's inclusion in such a high-level regional policy document ensures that methane mitigation will receive the sustained attention required, fostering accountability, and encouraging the AMS to adopt policies aligned with global best practices.

This decision also aligns with ASEAN's commitment to international climate goals, including the Global Methane Pledge, strengthening the region's standing as a proactive participant in the global energy transition.

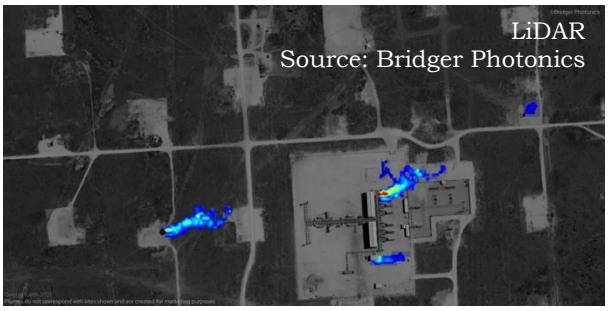
# 4. METHANE EMISSION MITIGATION TECHNOLOGIES AND PRACTICES

## 4.1. Methane emission mitigation technologies


Satellite monitoring
Source: ESA

Reducing methane emissions in the oil and gas industry requires the **deployment of a diverse array of technologies**, each designed to target specific emission sources and operational challenges. These technologies range from advanced detection and quantification systems that identify methane leaks with greater accuracy to mitigation solutions that capture or prevent methane release at its source.

As regulatory pressures intensify and the industry seeks to align with global emissions reduction targets, the integration of such technologies is becoming an essential pillar of methane abatement strategies. Their widespread adoption not only **enhances environmental performance** but also **supports operational efficiency** and **regulatory compliance** across the sector.


LiDAR
Source: Bridger Photonics


Optical Gas Imaging
Source: Well Said

The technologies examined in this section encompass a broad range of solutions, from relatively **simple and cost-effective** measures to **more advanced, high-tech systems**. Each offers distinct advantages in terms of efficiency, scalability, and cost-effectiveness, depending on the specific operational context in which they are deployed.


Vapour Recovery Unit
Source: GENERON

Whether through the replacement of outdated equipment with more efficient alternatives, the installation of systems to capture vented gas, or the implementation of monitoring programmes to detect leaks at an early stage, these technologies play a crucial role in mitigating methane emissions.

However, the adoption and integration of these technologies present their own **challenges**, including cost considerations, potential operational disruptions, and the requirement for specialised expertise. Successfully overcoming these barriers is essential to ensuring the widespread implementation of effective methane abatement strategies across the industry.

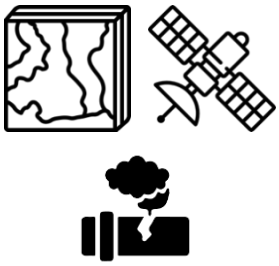
**Table 2.** Methane emission mitigation technologies by process

| Process | Technologies | Practical Technologies | Description/Function |
|---|---|---|---|
| **Detection, Measurement, and Quantification** | **Satellite monitoring** | Hyperspectral imaging | Hyperspectral imaging detects methane by analysing its unique spectral signatures, enabling satellites to identify even minor emissions. This technology supports daily global monitoring of pipelines, tracks emission patterns, and reduces environmental risks. |
| | | High-resolution satellite imagery | High-resolution satellite imagery detects methane leaks by capturing visual changes, such as vegetation stress or surface alterations, providing critical insights to prioritise leak detection and repairs. |
| | **Airborne technologies** | Gas mapping Light Detection and Ranging (LiDAR) | It uses advanced laser technology to detect, locate, and quantify methane emissions by measuring light absorption at specific wavelengths, making it effective for monitoring oil and gas facilities. |
| | **Ground-based instruments** | Optical Gas Imaging (OGI) camera | A specialised technique used to detect and visualise methane leaks through infrared technology. OGI cameras capture infrared radiation emitted by gases, which is invisible to the naked eye, thereby allowing operators to see gas plumes as visible clouds. |
| | | Laser leak detection | It identifies and quantifies methane emissions from a safe distance by using infrared laser beams to measure the absorption characteristics of methane molecules in gas plumes. |
| | | Acoustic leak detection | A technology used to identify methane leaks by detecting the sound waves generated by escaping gas. This method utilises specialised microphones or acoustic cameras that capture ultrasonic frequencies emitted from gas leaks, which are typically inaudible to the human ear. |
| | **Advanced sensor technologies** | Tunable diode laser absorption spectroscopy (TDLAS) | A sensitive technology used to measure methane concentrations by emitting a tunable laser beam at specific wavelengths. As the laser light passes through a gas sample, methane absorbs some of the light, |

| | | | |
|---|---|---|---|
| | | | causing a decrease in intensity, which is measured to determine the concentration of methane. |
| | | Continuous fixed monitors | It provides real-time data on methane levels, allowing operators to promptly identify leaks and assess emission trends. They are equipped with alarms to notify operators of detected leaks, enabling swift intervention. Advanced technologies, such as infrared sensors and laser-based systems, ensure precise measurements. |
| **Abatement** | **Low-bleed pneumatic devices** | | Specialised control instruments used in the oil and gas industry that are designed to minimise methane emissions during operations. These devices are characterised by their bleed rates, which refer to the amount of natural gas they vent into the atmosphere. Specifically, low-bleed pneumatic devices are defined as those that emit less than six standard cubic feet per hour (scfh) of natural gas. |
| | **Vapour recovery units (VRU)** | | A specialised system designed to capture and recover vapours that are emitted during the loading and unloading processes of hydrocarbons, such as crude oil and gasoline, as well as from storage tanks. These units are critical in mitigating fugitive emissions—unwanted gas releases that can occur when pressure in storage tanks needs to be relieved, or during the transfer of liquids. |
| | **Leak detection and repair (LDAR)** | | A systematic process aimed at identifying and rectifying fugitive methane emissions from oil and gas operations. It is considered to be an abatement technology because it both detects and corrects the situation after a leak occurs. This approach involves the use of various technologies, such as infrared cameras, laser leak detectors, and acoustic sensors, to locate unintentional leaks in equipment and infrastructure. Once detected, repairs can range from simple fixes, like tightening connections, to more complex interventions requiring facility shutdowns. |

### 4.1.1. Detection, Measurement, and Quantification

The process of **detection** in the oil and gas industry focuses on identifying the presence of methane emissions and their potential sources.



The primary purpose of detection is to locate where leaks or emissions are occurring without necessarily measuring the exact volume of gas released. Technologies such as **hyperspectral imaging**, **satellite imagery**, and **optical gas imaging** play key roles in identifying these emissions. By recognising emission hotspots, detection serves as the first step in the methane mitigation process, enabling operators to prioritise further investigation and response.

Once methane emissions are detected, the next step is **measurement**, which involves determining the concentration of methane in the air or at specific emission points. This process quantifies how much methane is present in each area or sample, but does not directly provide an emission rate over time. Technologies such as **laser absorption spectroscopy**, **drones equipped with methane sensors**, and **ground-based sensors** are commonly used for this purpose. Accurate measurement is essential for understanding the scale of the emission and informing subsequent efforts to reduce or control it.

The final stage, **quantification**, builds upon detection and measurement to calculate the actual emission rates of methane over a specified period. Quantification integrates concentration data with additional parameters, such as emission duration, flow rates, and environmental conditions, to provide a comprehensive assessment of methane emissions. This process is critical for understanding the extent of emissions from oil and gas operations, and developing effective mitigation strategies. Quantification technologies often combine **satellite data**, **sensor measurements**, and **advanced modelling techniques** to produce reliable emission rate estimates.

Together, these processes—detection, measurement, and quantification—form a **systematic approach** to **monitoring methane emissions in the oil and gas sector**, enabling operators to **identify leaks**, **assess their severity**, and **take targeted actions** to **effectively reduce methane emissions**.

While the technologies shown in Table 2 are applicable to mitigating methane emissions through detection, measurement and quantification, they also come with challenges. Satellite technologies, like hyperspectral imaging, face **atmospheric interference** from clouds and aerosols, reducing accuracy, especially over water or cloudy regions. **Spatial resolution constraints** limit detection of smaller or localised sources, while **temporal gaps** due to infrequent revisits can miss short-lived emissions. Ground-based **validation** remains essential to ensure data accuracy.

Airborne systems, such as gas mapping LiDAR, provide high-resolution data, but are affected by **environmental conditions** like wind and temperature. **High operational costs** and **logistical complexities** also hinder regular use, while missing smaller leaks.

Technologies like optical gas imaging and laser detection offer high sensitivity, but require **regular maintenance** and calibration. **Environmental factors**, such as wind dispersing gas plumes, and limited **spatial coverage** make large-scale monitoring challenging without deploying multiple sensors. Systems like TDLAS and continuous fixed monitors provide accurate data, but face issues like **calibration needs** and **data overload**, complicating analysis. Integration into existing frameworks requires significant infrastructure investment and personnel training.

### 4.1.2. Abatement

Abatement technologies play a crucial role in reducing methane emissions from oil and gas operations. **Low-bleed pneumatic devices** minimise methane released during equipment operations by replacing high-bleed systems. **Vapour recovery units** capture and reuse methane emissions that would otherwise escape during production and processing. **Leak Detection and Repair (LDAR)** programmes identify and fix methane leaks, ensuring timely intervention to reduce emissions effectively.

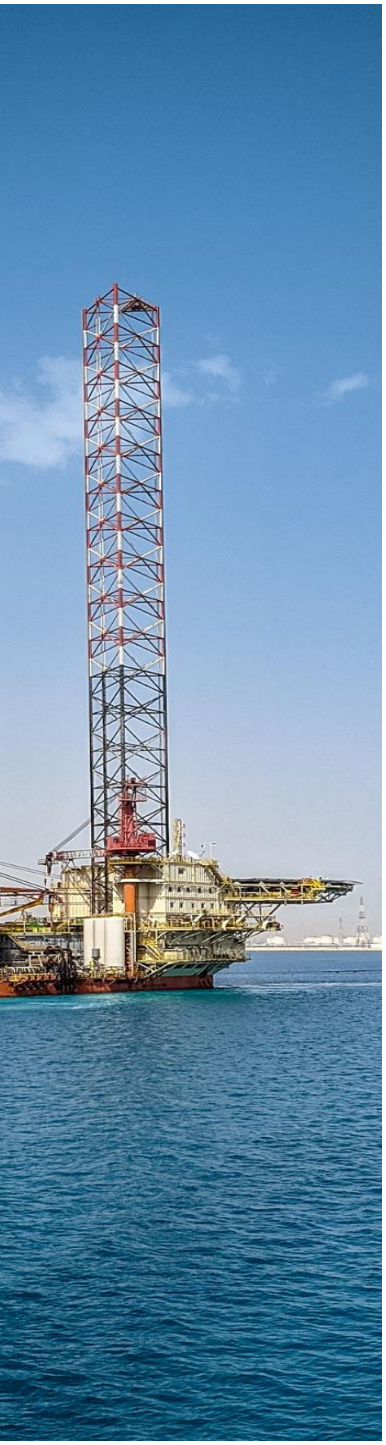
While low-bleed devices reduce emissions, they can **malfunction** due to wear or poor maintenance, exceeding intended bleed rates. The **cost** of transitioning from high-bleed systems and **technical limitations** in certain applications further hinder adoption, though inconsistent **regulatory compliance** complicates widespread implementation.

VRUs face challenges related to **high costs** and the need for **regular maintenance** to ensure efficiency. Their **design complexity** requires tailoring to specific conditions, limiting applicability for low-throughput operations. **Environmental factors**, such as temperature and pressure changes, can also impact performance.

LDAR systems face limitations from the **frequency of inspections** and **environmental factors** like wind or humidity, which affect detection accuracy. A **lack of standardisation** across regions causes inconsistencies, and **repair processes** can be costly and disruptive, especially if they require facility shutdowns.

## 4.2. Methane-targeted abatement technologies implemented by ASEAN's state-owned enterprises

### 4.2.1. Pertamina[5]



One cornerstone of Pertamina's methane reduction programme involves **addressing equipment leaks** and **operational inefficiencies**. By deploying **infrared cameras**, Pertamina can **detect leaks** from equipment with **precision**, enabling **timely repairs** and thereby significantly curtailing methane emissions from fugitive sources.

Another critical component of Pertamina's methane abatement strategy is the **reduction of flare gas**. The company is working towards minimising the use of flare gas by **replacing liquid fuels with gas alternatives** where feasible, and by **optimising gas sales** to both commercial and industrial consumers. This initiative helps in reducing the amount of methane released into the atmosphere through flaring.

Additionally, Pertamina is committed to lowering its energy consumption across various sectors by implementing an **Energy Management System (EMS)** [27]. This involves enhancing the efficiency of engine operations and optimising energy use in land, water, and air transportation, further contributing to methane emission reductions.

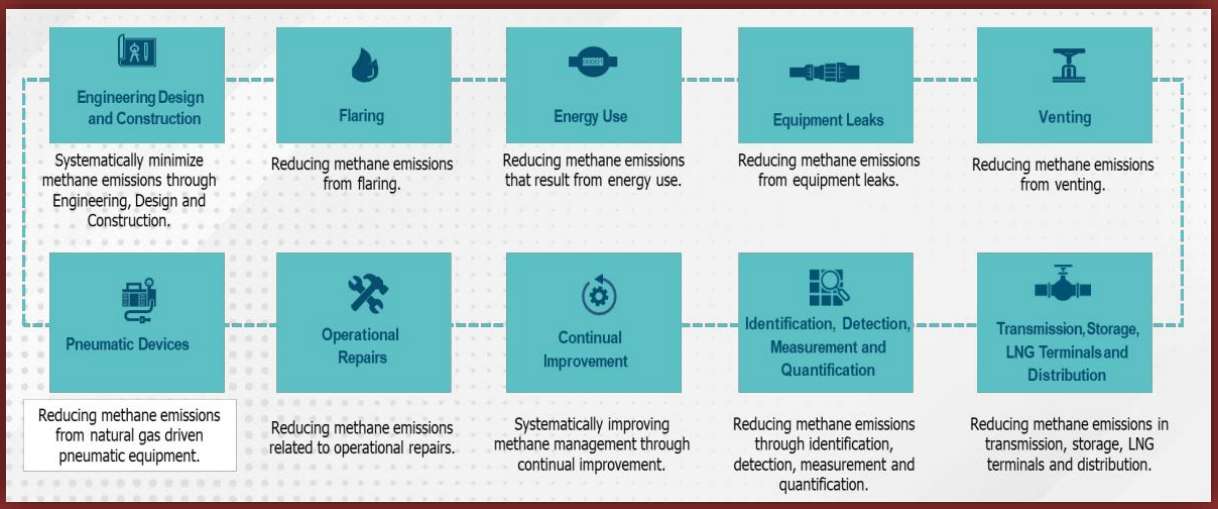
The company utilises several advanced technologies to accurately identify and measure methane emissions.

**Multi-gas detectors**, which are capable of detecting methane as well as other flammable gases like hydrogen sulphide ($H_2S$) and carbon monoxide (CO), are used extensively in drilling wells, both offshore and onshore, as well as in upstream and downstream facilities.

In addition, Pertamina employs **Forward Looking Infrared (FLIR) cameras** to visualise fugitive hydrocarbon leaks, including methane. These cameras are designed to be used safely in hazardous environments, such as well sites and offshore platforms. The EyeCGas IR camera is another tool in Pertamina's arsenal, providing imaging and recording capabilities for detecting gas leaks, including methane, in LNG facilities, refineries, and upstream operations.

[5] Delivered by Pertamina's representative at the USAID Smart Power Programme (SPP) Methane Workshop at Bangkok, Thailand, on 7 December 2022.

**Figure 9.** Pertamina's best practices in reducing methane emissions




Source: Pertamina, 2022

Pertamina's **best practices** in methane management encompass a range of strategies, as shown in Figure 9. From the **engineering design** and **construction phases**, to **operational maintenance**, the company systematically aims to minimise methane emissions. This includes reducing emissions from flaring and venting, managing emissions from pneumatic devices driven by natural gas, and addressing emissions related to equipment leaks and operational repairs.

The company has also committed to ongoing improvement in its methane management practices, which involves continual assessment and refinement of its strategies. Identifying, detecting, measuring, and quantifying methane emissions are integral to this process, as is reducing emissions throughout the transmission, storage, LNG terminals, and distribution stages.

Despite these comprehensive measures, Pertamina faces several challenges. One notable issue is the **quantification of methane emissions**. Currently, **emission factors** are used to **estimate methane levels**, but more precise methods are needed. The use of infrared cameras for detection requires sophisticated software and equipment to accurately quantify emissions.

Additionally, integrating methane detection with health and safety measures presents its own set of challenges. Infrared cameras, while effective in detecting methane, must also be capable of identifying other hazardous substances, such as benzene, toluene, ethylbenzene, and xylene, collectively known as BTEX, which complicates the detection process [27].

### 4.2.2. Petronas[6]

In alignment with **Principle 1** of the **Methane Guiding Principles**, Petronas is actively pursuing measures to mitigate methane emissions. In 2024, the company **advanced its initiatives** to reduce venting and flaring. Specific projects include the conversion of the **Temana vent to a flare**, and various energy efficiency projects within the upstream sector.

Additionally, Petronas is enhancing its reliability and integrity activities through its Key Results Area (KRA) programmes. These programmes focus on eliminating unplanned flaring and venting at upstream and gas facilities.

Notably, Petronas is also integrating technologies identified through its **Race2Decarb** open innovation challenge from 2023, such as valve stem sealants designed to prevent fugitive leaks.

To support **Principle 2**, Petronas is strengthening its collaboration with contractors under **Malaysia's Production Sharing Contract (PSC)**. This cooperative approach plays a key role in facilitating knowledge sharing on methane measurement technologies, improving emissions management in alignment with the Methane Guiding Principles and the United Nations Environment Programme Oil & Gas Methane Partnership 2.0 (UNEP OGMP 2.0). Such partnerships are essential for enhancing the effectiveness of methane emissions management strategies.

Under **Principle 3**, Petronas has made substantial investments to **improve the accuracy of its methane emissions data**. In 2023, the company explored various measurement technologies, including **Light Detection and Ranging (LiDAR)**, **Quantitative Optical Gas Imaging (QOGI)**, and **Systematic Observations of Facility Intermittent Emissions (SOOFIE)**. The adoption of QOGI technology in upstream operations has strengthened Leak Detection and Repair (LDAR) initiatives, improving the precision of methane emissions reporting for fugitive emissions, compressor seals, and tank releases.

Additionally, Petronas has piloted methane quantification technologies that integrate physical sensors with cloud-based systems, providing a more detailed and comprehensive understanding of its methane emission profile.

[6] Delivered by PETRONAS's representative at the USAID Smart Power Program (SPP) Methane Workshop at Bangkok, Thailand, on 7 December 2022.


Methane measurement under OGMP 2.0 reporting is classified into **different levels**, with **Level 4** offering the **highest accuracy** through direct site measurements. At this level, methane emission rates are calculated using actual site data, whereas **Levels 1 to 3** rely on **estimation methods** based on generic emission factors. To achieve the **OGMP Gold Standard**, companies must incorporate both Level 4 and 5 data and meet the requirement of reporting at these levels for **operated assets within three years** and **non-operated assets within five years**, as outlined in **Section 4.2.1 of the OGMP 2.0 Reporting Framework**.

Petronas, currently on the path to achieve the Gold Standard, employs a variety of measurement technologies, each with distinct applications and limitations. **Portable Flame Ionisation Detectors (FID)** measure methane concentrations in parts per million (ppm) or as a percentage of the Lower Explosive Limit (%LEL) at emission sources. Infrared (IR) cameras are effective for detecting leaks but cannot quantify concentrations or distinguish gas types.

The **QOGI hyperspectral camera** supports three usage modes—fixed, portable, and plane or UAV-mounted—enabling site-level and, to some extent, source-level quantification through proprietary algorithms. Drone- and plane-based methane sensors, such as **Light Detection and Ranging (LiDAR)** and **Tunable Diode Laser Absorption Spectroscopy (TDLAS)**, also depend on algorithmic processing for quantification.

Practical testing of these technologies has produced mixed results. **LiDAR** methane sensors were **trialled across various facilities**, including **pipelines**, **refineries**, and **offshore platforms**. While controlled tests yielded consistent concentration readings, **accurate quantification** depended on **precise wind speed measurements**. The technology effectively detected emissions and provided rough estimates of leak locations but struggled to measure methane clouds over water due to sensor limitations.

Petronas plans to **expand its technology trials** by testing the **QOGI fixed camera** in both **onshore** and **offshore** environments, as well as **flare efficiency hyperspectral cameras**. These trials aim to assess the effectiveness of these technologies in tropical conditions and confined spaces, such as offshore platforms, while also evaluating their capability to quantify emissions at both source and site levels.

### 4.2.3. PTTEP[7]


Source: PTT

PTTEP in Thailand has implemented a sophisticated approach to gas separation and leak detection, underscoring its commitment to maintaining energy security and enhancing the valuation of natural gas.

The company operates a dedicated **Gas Separation Plant (GSP)** that plays a crucial role in extracting and refining various hydrocarbon compounds from natural gas. This process not only maximises the economic value of natural gas, but also ensures a stable supply of liquefied petroleum gas (LPG) for domestic use, contributing significantly to Thailand's energy security.

PTTEP employs advanced technologies to monitor gas leaks and ensure operational integrity. The company utilises **Photoionisation Detectors (PIDs)** and **Forward-Looking Infrared (FLIR) cameras** to inspect gas leaks during routine operations.

The significance of such monitoring has been reinforced by Thai regulations. In 2012, the **Ministry of Industry** introduced legislation requiring the monitoring and control of **Volatile Organic Compounds (VOCs) emissions** from industrial equipment, including **compressors, pumps, valves,** and **flanges**. PIDs and infrared cameras are approved instruments under this regulation, which aligns with the **US Environmental Protection Agency (EPA) Method 21** for **VOC leak detection and alternative work practices.** Under this law, companies must report their monitoring results to the Ministry of Industry every six months.

Photoionisation detectors (PIDs) function by using **ultraviolet (UV) light** to **ionise gas samples**, allowing for the detection of VOC concentrations. When a gas molecule absorbs the high-energy UV light, it ejects a negatively charged electron, resulting in a positively charged ion. This ionisation process charges the gas molecules, which then produce a measurable electrical current quantified by the sensor electrodes. The non-destructive nature of PID measurements means that only a small portion of the VOC molecules are ionised, and the remaining sample can be preserved for further analysis.

Source: PTT

[7] Delivered by PTTEP's representative at the USAID Smart Power Program (SPP) Methane Workshop at Bangkok, Thailand, on 7 December 2022.

PTTEP also utilises innovative infrared camera technology to enhance its gas leak detection capabilities. The **FLIR GF320**, for instance, represents a significant advancement in this field. This infrared camera is highly sensitive, capable of detecting even the **smallest methane emissions or other VOCs**. Its exceptionally high sensitivity mode, which detects temperature differences as small as 25 millikelvins (mK), allows for real-time visualisation of minor gas leaks. The FLIR GF320 can measure temperatures ranging from -40°C to +350°C with an accuracy of ±1°C, making it an invaluable tool for precise leak detection.

Infrared cameras, like the FLIR GF320, operate based on detecting temperature differences between the gas and its background. They utilise a spectral filter, typically around 3.3 micrometres, and are equipped with highly sensitive cooled detector technology that operates at approximately 70 Kelvin. This advanced technology ensures that even the faintest gas movements are detected, providing a clear visual representation of gas leaks that enhance overall safety and environmental protection measures.

# 5. BARRIERS AND CHALLENGES

The challenge of reducing methane emissions in the oil and gas sector across ASEAN countries is a **complex issue** that intertwines **regulatory**, **economic**, **technological**, and **infrastructural** and **operational factors**. Each of these areas presents its own set of obstacles, complicating efforts to address methane emissions comprehensively and effectively.

## 5.1. Regulatory and Policy

As of **January 2024**, only **Indonesia**, **Thailand**, and **Viet Nam** have regulations targeting methane emissions in the oil and gas sector, leaving other ASEAN countries without structured policies. This regulatory gap leads to inconsistent efforts and lacks clear directives for companies, underscoring the need for a more unified approach to methane management across ASEAN.

Establishing new policies is complex, requiring **localised**, **adaptable regulations** and **significant resources**.

Delays and inefficiencies often arise, exacerbated by the absence of incentives for companies to adopt methane reduction technologies. Without financial or operational benefits, industry investment in such technologies remains low, slowing implementation.

**Reliance on voluntary industry standards, rather than mandatory regulations, undermines the effectiveness of methane reduction efforts due to inconsistent application**.

Furthermore, the lack of **unified regional standards** for **measurement**, reporting, and certification complicates tracking methane emissions, while **limited participation in global initiatives restricts access to international support**. This situation hinders regional methane management efforts, as inconsistent methods and limited collaboration impede the creation of an effective regional strategy.

Learning from the authors' discussion with **Pertamina**, domestic GHG management within Indonesia's oil and gas sector **operates on a spectrum of semi-voluntary commitments and regulated frameworks**. Pertamina, as a state-owned enterprise (SOE), actively supports government-led programmes, aligning its policies with national objectives.

Pertamina has outlined its Net Zero Emissions Roadmap, targeting net-zero emissions by 2060 or sooner. This medium-term goal, established in 2022, aligns closely with Indonesia's Enhanced Nationally Determined Contributions (NDC),

which aim for 31.89% emission reductions.

While Indonesia's energy sector contributes 15% to the NDC target, **Pertamina's approach is more aggressive**, reflecting its ambition to lead in emission abatement. Recognising that methane emissions are largely influenced by external factors, Pertamina remains committed to **addressing investor expectations and global commitments** through targeted initiatives, such as the **Oil and Gas Climate Initiative (OGCI)** and **OGMP 2.0**.

In May 2024, Pertamina joined OGMP 2.0 and is currently developing its Roadmap and implementation plan on methane emission management, demonstrating its strong dedication to meeting the expectations of investors and stakeholder. Furthermore, Pertamina has endorsed **World Bank's Zero Routine Flaring Initiatives in 2024**, strengthening its commitment in addressing climate change issues and taking part in global initiatives. These efforts demonstrate commitment, but concerns remain regarding the feasibility of achieving such ambitious goals.

Indonesia's national methane target of a 30% reduction also faces **challenges** due to its reliance on FOLU (Forestry and Other Land Use) strategies, with **limited contributions expected from the energy sector**. Pertamina's methane management currently focuses on measurement efforts, which are evolving but not yet systematic. Thus, by joining OGMP 2.0, Pertamina will align these measurements with the OGMP 2.0 framework.

Systematising these measurements would involve significant costs, potentially impacting operational efficiency, thus presenting a significant challenge for the company and the broader sector.

## 5.2. Economic and Financial

The economic and financial aspects of methane emission abatement present significant hurdles for the oil and gas sector in ASEAN. One of the primary challenges lies in the **high costs** associated with advanced technologies required for monitoring, detection, and abatement. For example, Leak Detection and Repair (LDAR) programmes, which are essential for quantifying fugitive emissions, involve substantial additional expenses. Scaling these efforts across hundreds of facilities only compounds the financial burden, making it a significant operational challenge for companies.

Another major issue is the **lack of regulatory mandates** in certain areas, which makes spending on abatement measures less justifiable from a financial standpoint. Without compulsory regulations, companies often struggle to allocate resources for emissions management, especially given the high upfront costs of developing systematic monitoring frameworks and upgrading facilities to meet higher sustainability standards, such as Level 4 or Level 5 monitoring requirements.

Flaring and venting reductions offer revenue potential but are not straightforward to implement due to **technical complexities** and **associated costs**. Fugitive emissions also present **dual challenges**, as they not only require **financial investment** for mitigation, but also **pose safety risks**, necessitating additional resources for safety protocols and equipment upgrades.

The variability in carbon market mechanisms, such as **Voluntary Carbon Markets (VCM)**, adds another layer of uncertainty. Companies must navigate different frameworks and price structures, complicating financial planning.

Furthermore, the integration of climate-related issues into broader energy sustainability strategies remains in a **nascent stage**, leaving knowledge gaps that must be addressed to elevate operational capabilities.

Overall, the economic and financial challenges of methane emission abatement revolve around three interconnected factors: **planning**, **systems**, and **people**. Adequate planning is essential to optimise resource allocation, systems must be developed to streamline monitoring and abatement processes, and workforce capabilities need to be enhanced to manage and sustain these initiatives effectively. These interconnected challenges underscore the pressing need for strategic investment and capacity building in the sector.

## 5.3. Technology, Infrastructure, and Operational

Technological barriers significantly hinder methane reduction efforts. Capturing methane is **energy-intensive**, often offsetting some environmental benefits.

Methane is also harder to convert into stable forms than $CO_2$, complicating its management. Limited awareness of methane abatement technologies in ASEAN further delays adoption, as companies often lack information on costs, benefits, and available solutions.

The region's **limited R&D** and few pilot projects exacerbate this challenge, slowing progress in addressing methane emissions effectively. Additionally, measuring methane emissions remains complex. **Top-down methods** can miss individual emission sources, while **bottom-up approaches** may overlook unexpected emissions, leading to data inaccuracies.

Equipment like valves and gas-driven controllers in oil and gas operations emit methane during regular use, adding to total emissions and making comprehensive reductions more challenging.

Insufficient infrastructure for methane capture and processing compels many companies to vent methane, highlighting a need for modernisation investments.

ASEAN's archipelagic geography adds complexity, requiring varied monitoring systems tailored to local conditions. Frequent natural disasters further exacerbate challenges, risking infrastructure damage and increased methane leaks.

Many oil and gas companies also rely on flaring and venting excess gas, which significantly contributes to emissions, showing the necessity for improved methane management strategies and technologies.

# 6. REGIONAL COOPERATION ON METHANE EMISSIONS IN THE ENERGY SECTOR

## 6.1. ASEAN Energy Sector Methane Roundtable

The ASEAN Energy Sector Methane Roundtable is a key initiative in methane emissions abatement, launched to support regional efforts in tackling climate change and promoting sustainable practices within the oil and gas sector. The inaugural session was held virtually on 26 October 2021, ahead of COP26, underscoring ASEAN's commitment to global climate mitigation goals (see the stakeholders below).


The roundtable was established to strengthen the expertise of industry practitioners and address information gaps in methane management within the oil and gas sector. Recognising that inconsistent practices and limited knowledge were hindering effective methane abatement, the sessions have focused on targeted upskilling for sector professionals.

To this end, the roundtable has committed to a biennial schedule over a five-year period, with each session hosted by leading energy companies in ASEAN. This rotating format not only strengthens regional partnerships, but also encourages each host to bring their unique expertise and experiences to the table.

**ASEAN Energy Sector Methane Roundtable** → Started In 2023 → **ASEAN Energy Sector Methane Leadership Program**

As the roundtable continues to facilitate discussions and knowledge sharing, the MLP provides a practical outlet for implementing these insights, bridging the gap between high-level policy discussions and on-the-ground methane abatement practices.

## 6.2. ASEAN Energy Sector Methane Leadership Program

The ASEAN Energy Sector Methane Leadership Programme (MLP) represents a cornerstone in the region's collaborative efforts to reduce methane emissions in the oil and gas industry. Since its inception, the MLP has aimed to provide an evolving platform for capacity building, knowledge-sharing, and policy alignment within ASEAN, with particular focus on advancing best practices in methane measurement, reporting, and mitigation.

Structured in two phases, MLP 1.0 and MLP 2.0, the programme has progressively expanded its scope to address the complexities of methane management across the oil and gas value chain, ultimately supporting the objectives of the Global Methane Pledge.

### MLP 1.0 Building Foundations for Methane Management


Launched in June 2023, MLP 1.0 served as an introductory phase, laying the groundwork for the AMS and industry players to develop a robust understanding of methane emission management. The first session, "**MLP Launch & Deep Dive on Methane Emissions Management**," presented technical sessions focused on existing frameworks for methane measurement and reporting, including the OGMP 2.0 standards [28].

**Figure 11.** 1st Masterclass Training Introduction to Methane Emissions Management, November 2023

Source: ASEAN Centre for Energy (ACE), 2025

Participants explored available methodologies for accurately quantifying emissions from individual facilities and clusters, setting the stage for more sophisticated monitoring and reporting practices within the region.


Source: ACE

In November 2023, the "**Introduction to Methane Emission Management and OGMP 2.0 Masterclass**" was held, offering a dual-track approach to accommodate different experience levels [29].


Source: ACE

The Introductory Track covered fundamental topics, including emissions calculations, methane monitoring technologies, and practical strategies for emissions reduction. Meanwhile, the Advanced Track delved into more strategic aspects, such as change management and methane accounting within the OGMP 2.0 Framework.

This provided a deeper dive into aligning business practices with internationally recognised methane standards.

In March 2024, the MLP hosted a masterclass titled "**Methane Emission Measurement: Policy Direction, Tools, and ASEAN Experiences**". This session highlighted the global policy landscape, featuring insights into U.S. and international regulatory frameworks, as well as certification programmes [30].

Participants were introduced to advanced methane data management tools like Mist, along with technologies aimed at achieving OGMP Levels 4 and 5.

**Figure 12.** 2nd Masterclass Training Policy Direction, Tools and ASEAN Experiences


Source: ASEAN Centre for Energy (ACE)

The final session of MLP 1.0, held in August 2024, focused on "**Tools for Designing and Financing Methane Mitigation Projects**". This session addressed the practical aspects of methane reduction, covering technology options, project design, and funding opportunities. Participants learned how to navigate available funding mechanisms, engage financial institutions, and craft project proposals to secure financing for methane mitigation initiatives [28].

It brought together experts and practitioners to explore opportunities and challenges in financing methane mitigation projects. Panellists from organisations such as **MiQ, Honeywell, PIMCO, EDF, and the U.S. CLDP** shared insights on investment strategies, measurement technologies, project design, and the role of certifications in enabling methane finance. Presentations from SLB, USTDA, the World Bank, and JP Morgan covered technical and financial frameworks, while Chevron Thailand showcased practical approaches in the Gulf of Thailand.

The session featured an interactive exercise where participants developed and pitched methane abatement project proposals based on a case study, including budgeting and financing strategies. A panel of experts provided feedback and awarded mock funding to selected proposals. In total, 35 participants received certificates, reflecting improved understanding of methane mitigation project design and financing.

**Figure 13.** 3rd Masterclass Training Tools for Designing and Financing Methane Mitigation Projects


Source: ASEAN Centre for Energy (ACE)

# MLP 2.0
# Turning Capacity into Action

With the foundation set by MLP 1.0, it transitioned into MLP 2.0, with a renewed focus on implementing and scaling methane mitigation actions across ASEAN's oil and gas sector.

Launched under the theme "**Turning Capacity into Action**," MLP 2.0 seeks to advance the region's methane abatement capabilities across the entire value chain, thus enhancing the industry's contribution to the Global Methane Pledge. MLP 2.0 will assist both public and private sector partners in moving from learning to proactive implementation of methane reduction strategies.

A key objective of MLP 2.0 is to demonstrate ASEAN's **leadership** in methane emission reduction, both regionally and globally. By signalling firm commitments to methane abatement, the programme aims to inspire industry-wide change, foster accountability, and raise awareness among stakeholders of the importance of methane management.

This objective underpins efforts to **strengthen companies' methane mitigation plans and set achievable, measurable targets** aligned with the Global Methane Pledge. MLP 2.0 will provide resources, tools, and practical solutions to aid companies in setting reduction targets and tracking progress effectively.

Another crucial element of MLP 2.0 is **exploring financing options** for methane abatement projects. Recognising that financial constraints can hinder implementation, MLP 2.0 aims to identify and secure funding for methane mitigation efforts.

By connecting companies with financing institutions and presenting innovative solutions that meet regional targets, the programme seeks to accelerate the adoption of technologies and practices that will drive tangible emission reductions.

In addition to capacity building and financing, MLP 2.0 will also focus on **fostering connections** between public organisations and private sector entities, encouraging collaboration on methane abatement technologies and services.

Through these partnerships, MLP members will have opportunities to engage in knowledge-sharing, technology exchanges, and contracts for methane abatement solutions. This collaborative approach will be instrumental in driving cross-border initiatives and harmonising methane management practices across ASEAN.


Lastly, the Methane Leadership Program (MLP) 2.0, as a continuation of MLP 1.0, was welcomed by the Joint Ministerial Statement of the 42nd ASEAN Ministers on Energy Meeting (AMEM) as one of the key outputs of ongoing methane mitigation efforts in the region.

**Joint Statement on Decarbonisation and Methane Emissions Reduction from Organisations in the Southeast Asian Energy Sector**

It also stands as a deliverable under the Joint Statement on Decarbonisation and Methane Emission Reduction from Organisations in the Southeast Asian Energy Sector, reinforcing ASEAN's growing leadership and commitment to tackling methane emissions in alignment with global decarbonisation goals.

The statements' alignment with MLP 2.0's objectives demonstrate the importance of cohesive policy frameworks in supporting industry-led initiatives for sustainable methane management.

The ASEAN Energy Sector Methane Leadership Programme, through its phases MLP 1.0 and MLP 2.0, has established a comprehensive framework for regional cooperation in methane abatement. By combining technical training, policy alignment, financing, and public-private collaboration, the MLP is equipping ASEAN's oil and gas sector to meet the future challenges of methane management.

## 6.3. Methane Abatement Towards a Sustainable Petroleum Industry

The Methane Abatement towards A Sustainable Petroleum Industry (MAESTRO) project represents a significant step in Southeast Asia's methane reduction efforts, creating a structured, data-driven approach to managing methane emissions in the energy sector.

Supported by the ASEAN Centre for Energy and the World Bank's GFMR, MAESTRO underscores ASEAN's commitment to addressing methane, a potent greenhouse gas. The initiative spans **data collection**, **policy development**, **capacity building**, and **pilot mitigation measures**, aiming to advance a sustainable petroleum industry.

Central to MAESTRO is its focus on **data transparency**. The project has established the region's first robust database for tracking oil and gas methane emissions, showcased through the **ASEAN Oil and Gas Methane Emissions Dashboard** launched in October 2024. This platform enhances visibility, enabling stakeholders to monitor emission hotspots and make informed decisions.

Building on reliable data, MAESTRO is developing an ASEAN-specific road map for methane mitigation, integrating cost-effective technical and policy solutions. Strategies include advanced detection technologies and incentivising low-emission practices tailored to regional economic and environmental contexts.

Capacity building is also pivotal, equipping policymakers and industry players with the knowledge and skills for effective methane management. Through training sessions and workshops, the project aims to bridge knowledge gaps and encourage sustainable practices.

**Phase 1**, initiated in 2024, has established a baseline for emissions and advanced the development of a regional roadmap report to guide future action. Complementary activities include technology assessments, case studies, and stakeholder engagement to build a comprehensive emissions profile.

**Scan to Access the Dashboard**

## 6.4. Optimising Methane Emission Governance and Abatement in ASEAN's Oil and Gas Sector

The Optimising Methane Emission Governance and Abatement in ASEAN's Oil and Gas Sector (OMEGA) project is a collaborative initiative by ACE and the United Nations Climate and Clean Air Coalition (UN CCAC) to address methane emissions in the region's oil and gas sector. Targeting **governments**, **oil and gas companies**, and **local communities**, it aims to strengthen governance, enhance technical capacity, and foster regional commitments for effective methane mitigation.

Collaborate

CLIMATE & CLEAN AIR COALITION
TO REDUCE SHORT-LIVED CLIMATE POLLUTANTS

The project begins with a **Gap Analysis** to evaluate existing methane abatement measures across ASEAN, identifying technical, policy, and financial challenges. These insights will guide tailored interventions to enhance policymaking and implementation capacities.

OMEGA emphasises **policy enhancement** through **capacity building**. For national oil and gas companies, training initiatives will be tailored to the Gap Analysis findings, equipping them with strategies for robust methane abatement. For ASEAN policymakers, Policy Writeshops will facilitate the drafting of actionable regulatory frameworks.

**Key Beneficiaries of the Project**

- **Government**
- **Companies**
- **Community**

The OMEGA project focuses on three key outcomes to achieve its goals. **First**, it aims to enhance policymakers' capacity to draft effective methane abatement policies and regulations, supported by a comprehensive Gap Analysis Report and specialised Policy Writeshops.

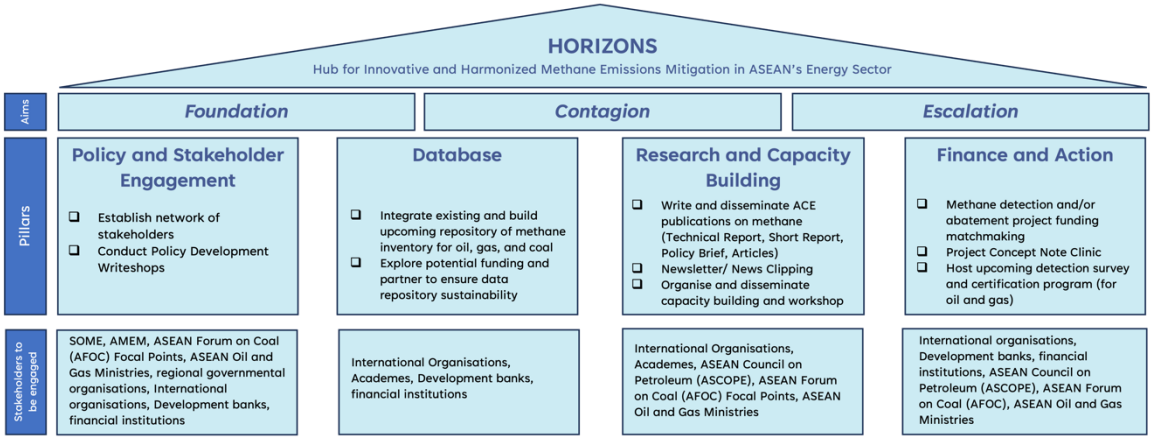
**Second**, the project seeks to strengthen corporate measures by enabling oil and gas companies to adopt more comprehensive mitigation practices through targeted capacity-building initiatives.

**Lastly**, OMEGA aspires to secure regional commitments by engaging ASEAN energy ministers, culminating in a project dissemination conference, and the inclusion of methane abatement commitments in the Joint Ministerial Statement.

## 6.5. Hub for Innovative and Harmonised Methane Emission Mitigation in the ASEAN's Energy Sector

The Proposed Hub for Innovative and Harmonised Methane Emission Mitigation in the ASEAN's Energy Sector (HORIZONS) initiative seeks to address key methane mitigation challenges in ASEAN's energy sector, by establishing a **dedicated regional Hub**. This Hub will focus on both the **oil and gas**, and **coal sectors**, providing a comprehensive platform to advance methane emission reduction efforts through four main pillars, including policy, database, research and capacity building, and financial.


**Figure 14.** HORIZONS framework




Source: ASEAN Centre for Energy (ACE), 2025

**Policy and Stakeholder Engagement** emphasises fostering collaboration among regional bodies, governments, and industries to align efforts toward methane reduction.

The **Database** introduces advanced, satellite-based monitoring capabilities to create a dynamic and comprehensive methane emission database, covering both the oil and gas, and coal sectors.

Under **Research and Capacity Building**, HORIZONS integrates innovative research with targeted training programmes to equip stakeholders with the knowledge and skills necessary for effective methane mitigation.

**Finance and Action** bridges the gap between aspirations and implementation, by linking stakeholders to funding opportunities for methane abatement projects. It supports the deployment of practical methane reduction measures, while aligning with global initiatives.

## 7. RECOMMENDATIONS

The issues surrounding methane emission abatement in ASEAN's oil and gas sector are diverse and interlinked, spanning regulatory gaps, financial constraints, technological barriers, and operational complexities. Despite the progress made by some countries and industry leaders, significant hurdles remain in achieving systematic and cost-effective methane management.

These challenges highlight the urgency of a coordinated and comprehensive approach to methane reduction, one that leverages regional collaboration, international support, and innovative strategies. Addressing the barriers requires actionable recommendations that not only resolve the current obstacles, but also lay the foundation for a sustainable and resilient oil and gas sector in the region.

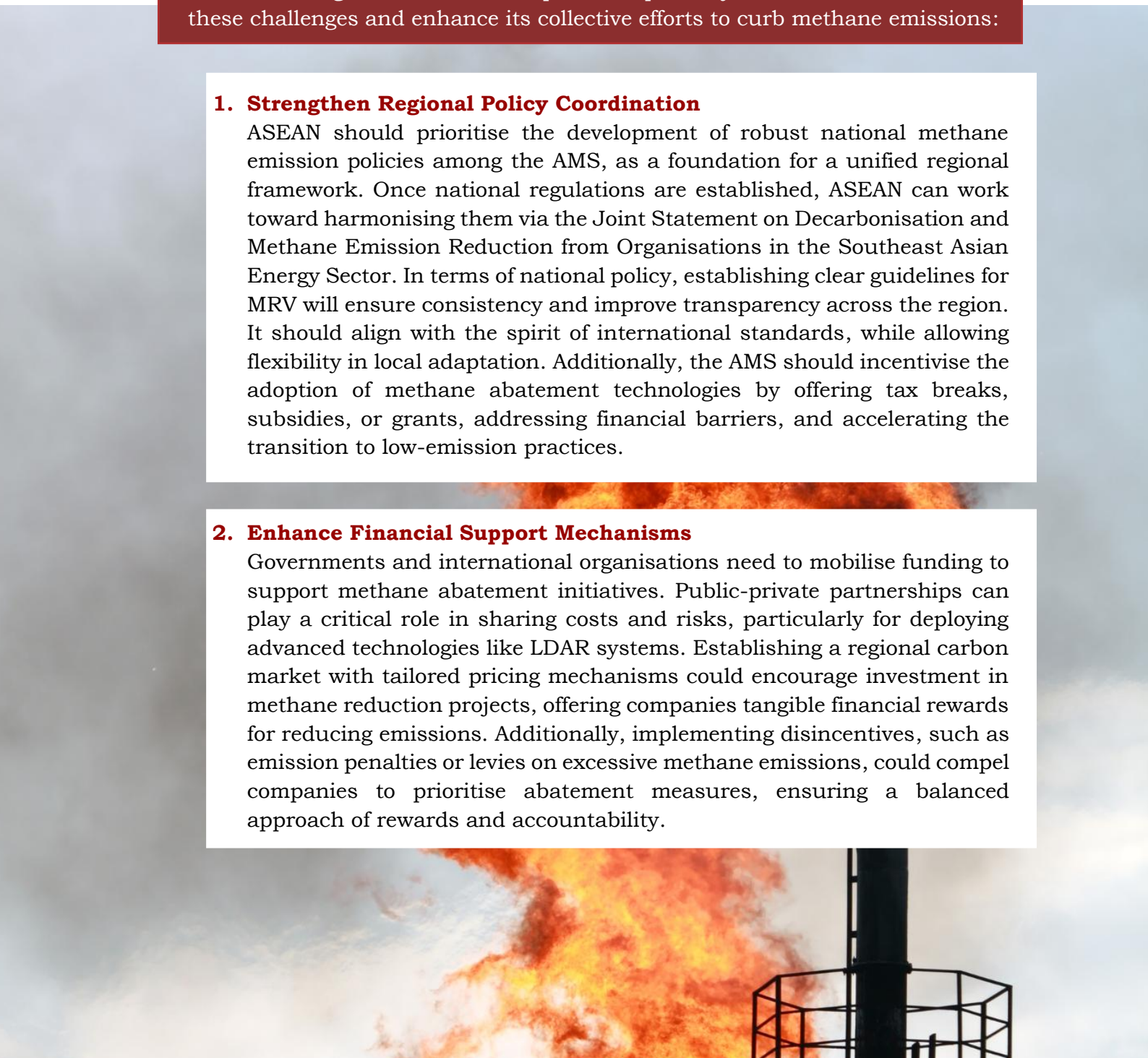
The following recommendations provide a pathway for ASEAN to overcome these challenges and enhance its collective efforts to curb methane emissions:

### 1. Strengthen Regional Policy Coordination

ASEAN should prioritise the development of robust national methane emission policies among the AMS, as a foundation for a unified regional framework. Once national regulations are established, ASEAN can work toward harmonising them via the Joint Statement on Decarbonisation and Methane Emission Reduction from Organisations in the Southeast Asian Energy Sector. In terms of national policy, establishing clear guidelines for MRV will ensure consistency and improve transparency across the region. It should align with the spirit of international standards, while allowing flexibility in local adaptation. Additionally, the AMS should incentivise the adoption of methane abatement technologies by offering tax breaks, subsidies, or grants, addressing financial barriers, and accelerating the transition to low-emission practices.

### 2. Enhance Financial Support Mechanisms

Governments and international organisations need to mobilise funding to support methane abatement initiatives. Public-private partnerships can play a critical role in sharing costs and risks, particularly for deploying advanced technologies like LDAR systems. Establishing a regional carbon market with tailored pricing mechanisms could encourage investment in methane reduction projects, offering companies tangible financial rewards for reducing emissions. Additionally, implementing disincentives, such as emission penalties or levies on excessive methane emissions, could compel companies to prioritise abatement measures, ensuring a balanced approach of rewards and accountability.



3. **Accelerate Technological Advancement and Adoption**

Increased investment in research and development (R&D) is crucial to develop cost-effective and scalable methane abatement solutions. ASEAN should establish regional centres of excellence to drive innovation, share best practices, and pilot new technologies. Promoting knowledge exchange through workshops and training programmes will enhance industry awareness and capacity to implement effective solutions.

4. **Modernise Operational Practices**

Companies should incorporate advanced monitoring systems tailored to local conditions, particularly in regions prone to natural disasters. For flaring and venting, governments can introduce stricter regulations alongside incentives for companies to capture and utilise methane, turning potential emissions into revenue streams.

5. **Elevate Workforce Capabilities**

Building a skilled workforce is vital for implementing and sustaining methane abatement efforts. Governments and companies should invest in training programmes focused on emission monitoring, advanced equipment maintenance, and safety protocols. This will ensure that employees have the technical expertise needed to navigate increasingly complex operational and regulatory landscapes.

6. **Foster Regional and Global Collaboration**

ASEAN should actively engage in international initiatives to leverage global expertise, financing, and technology access, recognising that regional collaboration amplifies the collective impact of methane management efforts. Addressing methane emissions is a transboundary challenge, as emissions from one country can impact the region's overall environmental and climate goals. Strengthening partnerships with international organisations and donor agencies will not only enhance technical and financial support, but also provide a platform for the AMS to develop consistent strategies and avoid fragmented efforts. ACE, through its Hub for Innovative and Harmonized Methane Emission Mitigation in ASEAN's Energy Sector (HORIZONS) project, plays a critical role in this collaboration, by serving as a regional platform for capacity building, policy development, and technology transfer. The Hub can help the AMS align national and regional strategies with global best practices, while tailoring solutions to local contexts, ensuring a cohesive and effective approach to methane management.

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# Contact

**ASEAN Centre for Energy**
**Soemantri Brodjonegoro II Building, 6th Fl.**
**Directorate General of Electricity**
**Jl. HR. Rasuna Said Block X-2, Kav. 07-08**
**Jakarta, 12950, Indonesia**
**Tel. (62-21) 527 9332 | Fax. (62-21) 527 93350**
**E-mail: secretariat@aseanenergy.org**
**www.aseanenergy.org**

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