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Study on Measures to Evaluate and Reduce Methane Emissions in the Liquefied Natural Gas Value Chain in ASEAN

by

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Preface

Methane emission management within the liquefied natural gas (LNG) value chain is increasingly gaining attention as initiatives to control these emissions gather momentum. For the LNG industry to capitalise on this momentum and leverage the growing awareness as a driving force, it must address the issue proactively and provide information with greater transparency.

Since the inception of the LNG industry in the 1960s and 1970s, it has been the greatest contributor in reducing methane emissions by capturing and utilising methane that would otherwise have been released uncontrolled into the atmosphere or flared, generating CO_2 emissions. This is especially true in Southeast Asia, where some of the pioneering LNG projects were developed during the industry's early days. However, this contribution is often dismissed or ignored. The LNG industry cannot afford to simply stop there. Methane emissions are often described as difficult to detect and quantify due to methane's colourless and odourless nature. The industry's tremendous efforts to contain and eliminate unintended methane releases—driven by safety, integrity, and economic reasons—have paradoxically made it challenging to quantify the already minimal methane emissions.

Whilst LNG offers numerous benefits, including enhancing economic competitiveness, environmental sustainability, and energy security (the 3Es) in Asia due to its relative cleanliness and lower CO_2 emissions compared with other fossil energy sources, it is now crucial to scientifically verify that methane emissions from the LNG industry are indeed minimal. Moreover, the industry must demonstrate its capacity to further reduce methane and CO_2 emissions.

The public often fails to understand that most methane emissions occur outside the LNG and gas industry. It can be difficult to distinguish between methane as a clean energy source and methane emissions as a contributor to global warming. Effective public relations efforts are therefore important to enhance the industry's image and convey its seriousness in tackling this issue.

Furthermore, gas systems vary significantly by country, with some emitting more greenhouse gases than others. Sharing best practices across the industry is vital to ensure its sustainability. However, these practices may need to be adapted to suit local conditions when applied in different regions.

It is also increasingly important to consider Scope 3 emissions. Producers must closely examine how their gas is ultimately consumed, as most CO_2 emissions in the value chain occur downstream during consumption. Similarly, consumers should scrutinise the production processes of their gas sources to ensure minimal harm, as most methane

emissions are suspected to occur upstream during gas production.

Both companies and regulatory authorities should take a closer look at corporate and site-specific emission profiles, as well as cargo-specific data, to ensure that clean gas is truly clean.

We hope this study will provide valuable insights for the sustainable development of the LNG market, particularly with better methane emission management.

Hiroshi Hashimoto

Leader of the Working Group

Acknowledgements

This study was undertaken in close collaboration with specialists and industry officials focused on methane and greenhouse gas emission management in the Association of Southeast Asian Nations (ASEAN) countries, Japan, and other regions. The authors would like to extend their sincere thanks to all participants in the two online workshops held on 20 December 2023 and 30 May 2024, as well as to those who provided feedback through written surveys following the events. Special thanks also go to the respondents of the survey conducted through the Asia Pacific Energy Research Centre (APERC) and to those interviewed by JGC Corporation and The Institute of Energy Economics, Japan (IEEJ).

The presentations and discussions at the workshops, featuring industry players from the region, government authorities, and stakeholders active in Southeast Asia and the United States, were very useful and inspiring. They played a key role in shaping future strategies and policy measures to support methane emission management initiatives.

The authors also wish to express their sincere appreciation to Glen Sweetnam, Senior Vice President of APERC, and the researchers on his team, for their kind and generous support throughout this study. Any errors and omissions remain the responsibility of the authors.

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List of Abbreviations and Acronyms

AGA	American Gas Association
API	American Petroleum Institute
ASEAN	Association of Southeast Asian Nations
AUSEA	Airborne Ultralight Spectrometer for Environmental Applications
CH_4	methane
CLEAN	Coalition for LNG Emission Abatement toward Net-zero
CO_2	carbon dioxide
COP	Conference of the Parties to the United Nations Framework Convention on Climate Change
DOE	Department of Energy
EPA	US Environmental Protection Agency
EU	European Union
GHG	greenhouse gas
GIIGNL	International Group of Liquefied Natural Gas Importers
GMI	Global Methane Initiative
GMP	Global Methane Pledge
IEA	International Energy Agency
IMEO	International Methane Emissions Observatory
IPCC	Intergovernmental Panel on Climate Change
JOGMEC	Japan Organization for Metals and Energy Security
LDAR	leak detection and repair
LNG	liquefied natural gas
MRV	measurement, reporting, and verification
N_2O	nitrous oxide
OGCI	Oil and Gas Climate Initiative
OGMP	Oil and Gas Methane Partnership

OGMP 2.0	Oil and Gas Methane Partnership 2.0
PTT	PTT Public Company Limited, Thailand
UK	United Kingdom
UN	United Nations
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
US$	US dollar
VRU	vapour recovery unit

Introduction

In recent years, international initiatives such as the Global Methane Pledge (GMP), the International Methane Emissions Observatory (IMEO), the Oil and Gas Methane Partnership 2.0 (OGMP 2.0), the Coalition for LNG Emission Abatement toward Net-zero (CLEAN), and the ASEAN Energy Sector Methane Leadership Program have highlighted the growing attention to methane emission management. Within this context, the natural gas value chain is increasingly seen as a 'low-hanging fruit' for emission reductions across the spectrum of methane emission sources. The global gas crisis in 2022 has further underscored the importance of sustainability in natural gas supply, alongside supply security.

One key reason for this attention is the suspected higher global warming potential (GWP) of methane over shorter time scales. Whilst methane is estimated to have a GWP of 29.8 over 100 years, its 20-year GWP is significantly higher at 82.5 (ECCC, 2022). Because of methane's shorter atmospheric lifespan compared with CO_2, the 20-year GWP has been increasingly cited in recent discussions.

The momentum behind methane emission management gained speed in mid-2023, with the issue being addressed at the annual LNG Producer–Consumer Conference in Tokyo and the Energy Asia event in Kuala Lumpur. Several international initiatives are also underway to develop standards for methane (and greenhouse gas [GHG]) emission measurement, reporting, verification (MRV), leak detection and repair (LDAR), and abatement measures.

The study aims to pursue a resilient strategy to address the methane emission issue across the natural gas value chain in the Association of Southeast Asian Nations (ASEAN) region—a region of significant importance in the global natural gas industry. Whilst methane emission issues have gained considerable attention in Western Europe and North America, the ASEAN region has been slower to recognise the importance of these issues, with regional governments lagging in policy and regulatory development.

The objectives of this study are the following:

- ✓ Promote understanding of methane emissions issues amongst regional stakeholders.
- ✓ Examine how emissions are monitored, managed, and reduced throughout the liquefied natural gas (LNG) and natural gas value chain in the region.
- ✓ Develop recommendations for relevant stakeholders—government authorities, regional industry organisations, and industry players—on addressing these issues through enhanced regional cooperation.

Ultimately, enhanced efforts to reduce and manage methane emissions should enable natural gas and LNG to play a pivotal role in the energy transition whilst improving energy security and resilience in the ASEAN region and Northeast Asia, which is expected to continue relying on ASEAN LNG supply, albeit to a lesser extent.

During the course of this study, the team noted that the United States (US), Canada, and Europe have been strengthening their efforts, with substantial international implications.

- ✓ The US Environmental Protection Agency (EPA) has issued a final rule to reduce methane and other air pollution emissions from oil and natural gas operations, alongside financial and technical support to curb methane emissions. Under the Inflation Reduction Act, the US introduced methane charges for facilities emitting more than 25,000 tonnes of CO_2 equivalent per year—ranging from US$900 per tonne in 2024 to US$1,500 per tonne in 2026.
- ✓ Canada has tightened its measurement and reporting regulations to reduce methane emissions from the oil and gas sector by 40%–45% below 2012 levels by 2025.
- ✓ The European Union (EU) initially focused on reducing methane emissions within its borders but has now set its sights on limiting emissions from fossil fuel imports as data becomes available. In May 2024, the Council of the European Union adopted the world's first regulation on tracking and reducing methane emissions from imports.

The ASEAN region has also seen notable developments in raising awareness of methane emissions, led by the industry itself. Since 2021, the ASEAN Methane Roundtable series (PETRONAS, 2021), led by Malaysia's PETRONAS, Thailand's PTT, and Indonesia's PERTAMINA, has made significant strides. PETRONAS joined the Oil and Gas Methane Partnership 2.0 (OGMP 2.0) in November 2022 (PETRONAS, 2022). The Japan Organization for Metals and Energy Security (JOGMEC) and JGC Holdings of Japan have also expressed willingness to cooperate in the region, including site-level emission measurement programmes.

During this study, two online workshops were held to enhance global and regional understanding of the issue. The study team remains committed to understanding the efforts and initiatives undertaken by companies, industry associations, and government authorities in the region to help develop effective strategy for tackling the issues.

Table 1. Notable Worldwide Developments in Methane Emission Management

Year	Europe	Asia	Americas	Global
2020	EU Methane Strategy / OGMP 2.0			
2021	IMEO EC introduction of legislative proposal	#1 ASEAN Methane Roundtable (led by PETRONAS, PTT, PERTAMINA)	EPA methane regulation proposal	Global methane pledge
2022	EU Council general agreement on methane legislation	#2 ASEAN Methane Roundtable	EPA methane regulation (supplement) proposal	The US, the EU, Japan, Singapore, Canada, Norway, and the UK joint declaration on reducing emissions from traded fossil fuels[Error! Reference source not found.],[Error! Reference source not found.]
2023	European Parliament position on methane legislation binding 2030 methane reduction targets and 2026 gas importer methane intensity standards[Error! Reference source not found.]	ASEAN Energy Sector Methane Leadership Program[Error! Reference source not found.] CLEAN asking methane emissions information from LNG suppliers	EU–USA Energy Council recognises needs to collaborate common approach on MMRV and reduction efforts[Error! Reference source not found.]	G7 Climate, Energy and Environment Ministers agree on methane emission reduction efforts and needs of MMRV standard[Error! Reference source not found.] MMRV Working Group starting to establish a voluntary standard led by US DOE and EC
2024	The EU Council adoption of regulation on tracking and reducing methane emissions, the world's first to regulate methane emissions from imports	CLEAN continuing dialogues with LNG suppliers	EPA final rule to reduce emissions from oil and natural gas operations	MMRV Working Group continuing

ASEAN = Association of Southeast Asian Nations; CLEAN = Coalition for LNG Emission Abatement toward Net Zero; EC = European Council; EPA = US Environmental Protection Agency; EU = European Union; G7 = Group of Seven; IMEO = International Methane Emissions

Observatory; LNG = liquefied natural gas; MMRV = measurement, monitoring, reporting, and verification; OGMP 2.0 = Oil and Gas Methane Partnership 2.0; UK = United Kingdom; USA = United States of America; US DOE = United States Department of Energy.

The study team also identified several 'inconvenient truths' concerning methane emissions in the LNG and gas industry, which must be addressed for the industry's survival:

1) Perception of the LNG and gas industry. The industry is often perceived as a major source of methane emissions, despite being the largest contributor to effective utilisation of methane that might otherwise have been emitted into the atmosphere or flared.
    a) The LNG and gas industry must now demonstrate that it is part of the solution to methane emissions rather than a cause. The industry has developed advanced technology to minimise methane emissions and maximise methane recovery.
    b) Quantifying methane emissions from LNG and gas systems is challenging, partly due to the industry's efforts to minimise these emissions.
    c) Effective public relations are crucial to portraying as serious about tackling methane emissions.
2) Inequality of LNG and gas systems. LNG and gas systems are not uniform; some emit more methane than others.
    a) Best practices must now be shared to preserve the industry's future.
    b) These practices may need to be adapted to local conditions when applied in different regions.
3) Scope 3 considerations.
    a) Producers must carefully examine how their gas production is eventually consumed.
    b) Consumers should scrutinise how their gas sources are produced without causing harm (emissions during the production process).
    c) Close attention should be paid to corporate, site-level, and cargo-specific emission profiles.

Given this background, the focus of this study is on methane emission management in the energy sector, particularly within the LNG and natural gas supply chain. The scope of the study encompasses methane emission status, policies, initiatives, frameworks, and related technologies. By comparing and analysing study results from various regions (global and ASEAN), the study provides recommendations for effective methane emission management tailored to the ASEAN region's characteristics.

Chapter 1

Global Methane Emissions

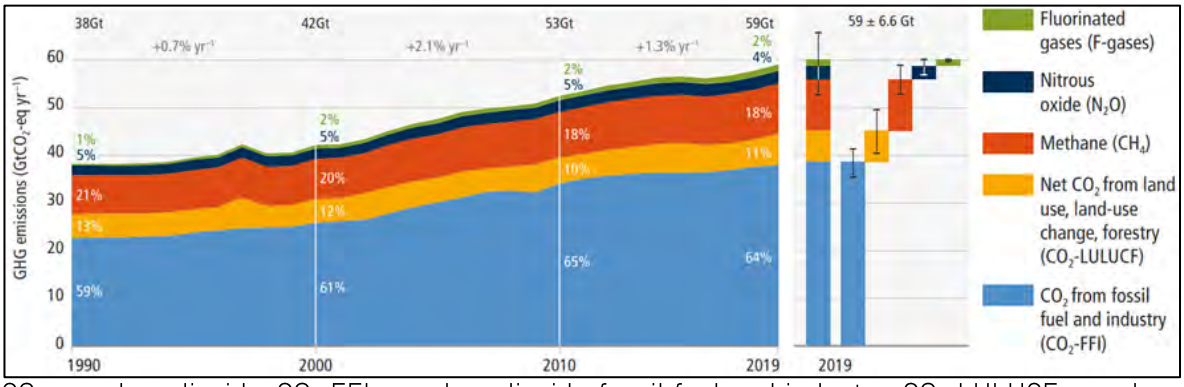
1. Methane Emissions Update

This chapter provides an analysis of estimated data compiled by various research institutes worldwide and summarises the current state and challenges of methane emission management globally, with a particular focus on the ASEAN region.

1.1. Intergovernmental Panel on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) is a United Nations body dedicated to assessing the scientific evidence related to climate change (IPCC, 1988). Its primary objective is to provide policymakers with regular scientific assessments on the latest developments in climate change research. Established in 1988 by the World Meteorological Organization and the United Nations Environment Programme (UNEP) (IPCC, 1988),Error! Reference source not found. the IPCC now includes participation from 195 countries and regions as of July 2024. The IPCC evaluates the latest scientific findings on climate change and produces two types of reports: periodic assessment reports and thematic special reports. These comprehensive scientific assessments have been released every 5 to 7 years since the First Assessment Report in 1990. The Sixth Assessment Report synthesis was published in March 2023. Policymakers worldwide frequently cite IPCC reports, which serve as the basis for international negotiations, including the United Nations Framework Convention on Climate Change (UNFCCC), as well as for domestic policy development.

Figure 1.1. Global Net Anthropogenic Greenhouse Gas Emissions (1990–2019)



CO_2 = carbon dioxide; CO_2-FFI = carbon dioxide-fossil fuel and industry; CO_2-LULUCF = carbon dioxide-land use, land-use change, and forestry; GHG = greenhouse gas; Gt = gigatonnes.
Source: IPCC Sixth Assessment Report (Working Group III) (2022).

The IPCC Sixth Assessment Report (Working Group I), published in August 2021, assessed that 'there is no doubt that the increases in atmospheric CO_2, methane, and nitrous oxide (N_2O) since the pre-industrial era have been caused by human activities.' The report also states that the composition of global GHG emissions in 2019 consisted of 75% CO_2 (64% of which is from fossil fuels), 18% methane, 4% N_2O, and the remaining 2% fluorinated gases and others. Whilst most GHG emissions are derived from fuel and industry-related CO_2, methane has a global warming potential 28 times higher than that of CO_2 and accounts for about 20% of total emissions.

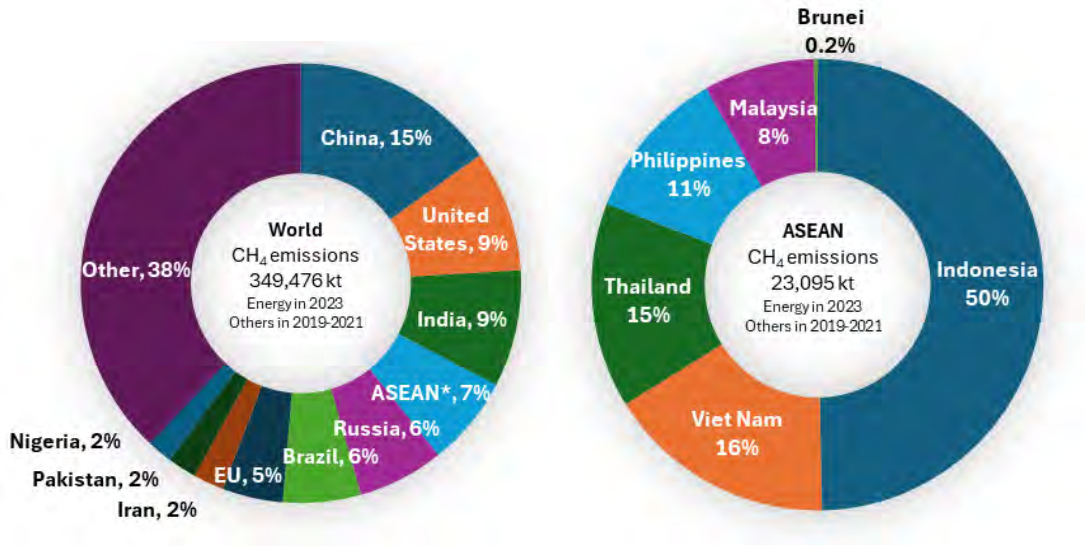
The IPCC is in its seventh assessment cycle, which formally began in July 2023 with the election of the new IPCC and taskforce bureaus at the IPCC's plenary session in Nairobi (IPCC, 2023).

1.2. Global Methane Tracker

The International Energy Agency (IEA) released the latest version of its Global Methane Tracker in March 2024, covering all sources of methane from human activities. For the energy sector, the tracker includes the IEA's estimates of methane emissions from the supply or use of fossil fuels (natural gas, oil, and coal) and bioenergy (such as solid bioenergy, liquid biofuels, and biogases). The IEA claims that the tracker 'provides our latest estimates of emissions from across the sector—drawing on the most recent data and readings from satellites and ground-based measurements' (IEA, 2024).

For non-energy sectors such as waste, agriculture, and other sources, the tracker provides reference values based on publicly available data sources, providing a comprehensive picture of methane emissions. The IEA's approach to estimating methane emissions from global oil and gas operations relies on generating country-specific and production type-specific emission intensities, which are then applied to production and consumption data on a country-by-country basis.

Figure 1.2. Global and ASEAN Methane Emissions (Share by Country) (2023)



ASEAN = Association of Southeast Asian Nations, CH_4 = methane, EU = European Union.
Note: The ASEAN countries included in the chart are Brunei Darussalam, Indonesia, Malaysia, the Philippines, Thailand, and Viet Nam. Cambodia, the Lao People's Democratic Republic, Myanmar, and Singapore are not included due to unavailability of data.
Source: Compiled from IEA Methane Tracker 2024 (IEA, 2024).

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Figure Figure 1.2 shows global methane emissions, estimated at 349.47 million tonnes in 2023, down 1.8% from 355.8 million tonnes the previous year. The largest emitter was China with 52.84 million tonnes (15% of the global total), followed by the US with 31.25 million tonnes (9%), India with 30.05 million tonnes (9%), and ASEAN with 23.09 million tonnes (7% of the global total). Within ASEAN, Indonesia accounted for the largest share with 11.47 million tonnes (50% of the ASEAN total), followed by Viet Nam with 3.79 million tonnes (16%) and Thailand with 3.39 million tonnes (15%).

Figure 1.3 summarises methane emissions by sector (agriculture, energy, waste, and others) for the world and the ASEAN countries. Agriculture is the largest source of methane emissions worldwide, accounting for 40%, followed by energy at 37%, waste at 20%, and other sources at 3%. However, the areas of focus vary by country: in Indonesia, 31% of emissions come from agriculture; in Viet Nam, 58%; in Thailand, 62%; in the Philippines, 68%; and in Malaysia, 49% from waste.

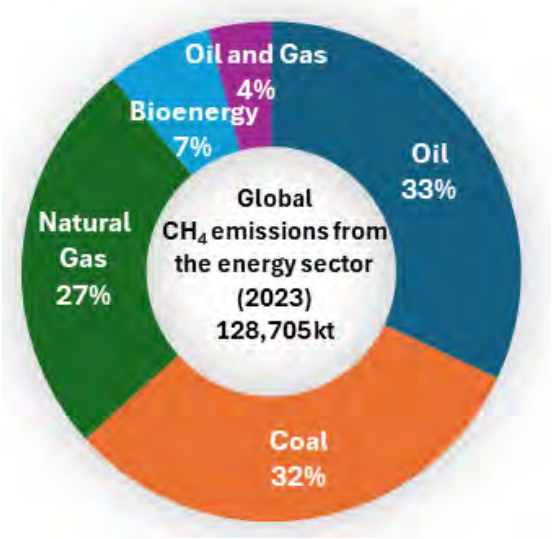
According to the IEA, methane emissions from the energy sector totalled 128.7 million tonnes in 2023 (Figure), down 3.5% from 133.3 million tonnes the previous year and down from a record high of 134.7 million tonnes in 2019. Over the last 10 years, emissions have remained largely unchanged, suggesting that the industry's and governments' efforts to reduce emissions may have had some success.

Oil, coal, and natural gas account for 33%, 32%, and 27% of the energy industry's total emissions, respectively (Figure 1.4)

Figure 1.3. Methane Emissions by Country (World, Indonesia, Viet Nam) (2023)

CH_4 = methane.
Note: Some data is not applicable.
Source: Compiled from the IEA Methane Tracker 2024 (IEA, 2024).

Figure 1.4. Composition of Global Energy Sector Methane Emissions (2023)



CH_4 = methane.
Note: Some data is not applicable.
Source: Compiled from the IEA Methane Tracker 2024 (IEA, 2024).

2. Natural Gas Production and Consumption in ASEAN Countries

Table 1.1 shows that Malaysia leads natural gas production in ASEAN, followed by Indonesia and Thailand, whilst Thailand is the largest consumer, followed by Malaysia and Indonesia.

According to the IEA, methane emissions from the gas sector in ASEAN stand at 0.50 million tonnes in Indonesia, 0.41 million tonnes in Malaysia, and 0.26 million tonnes in Thailand.

Although Malaysia is the largest natural gas producer in the region, its methane emissions are lower than Indonesia's, highlighting Malaysia's leadership in methane emission management within ASEAN.

In recent years, LNG imports have increased in Thailand, Singapore, and other ASEAN countries, with the Philippines and Viet Nam beginning LNG imports in 2023. As the region undergoes its energy transition, natural gas consumption in ASEAN is expected to increase, making it an even more important energy source.

Table 1.1. Natural Gas Production and Consumption by ASEAN Countries (2023)

Unit: Billion cubic metres (bcm)

	Production	LNG Export Volume	Pipeline Export Volume	Consumption	LNG Import Volume	Pipeline Import Volume
Brunei	10.0	6.2	-	-	-	-
Indonesia	64.3	16.1	4.5	45.4	-	-
Malaysia	81.1	36.3	-	46.1	3.2	0.4
Myanmar	15.2	-	9	-	-	-
Thailand	25.7	-	-	47.2	16.1	5.4
Viet Nam	7.2	-	-	7.2	-	-
Philippines	-	-	-	3.2	-	-
Singapore	-	-	-	12.3	6.8	6.2
Cambodia	-	-	-	-	-	-
Lao PDR	-	-	-	-	-	-

Lao PDR = Lao People's Democratic Republic, LNG = liquefied natural gas.

Source: Compiled from the 2024 The Energy Institute Statistical Review of World Energy™ (The Energy Institute, 2024).

3. Transparency and Accuracy of Methane Emissions

According to the Global Methane Tracker, advancements in technologies such as satellite monitoring are improving data transparency. However, in most parts of the world, methane emissions are still primarily reported using little to no direct measurement-based data.[Error! Reference source not found.] For example, UNEP's Oil & Gas Methane Partnership 2.0 member companies reported approximately 5 million tonnes of methane emissions in 2023, representing only 5% of the IEA's estimated total emissions from the gas and oil sector. In contrast, countries' total oil and gas emission reports to the UNFCCC amounted to around 40 million tonnes, representing just 50% of the IEA's 2023 estimate.

The discrepancies between reported data and estimated emissions stem from various factors, which should be addressed through more systematic and transparent use of measured data. According JOGMEC's carbon intensity guidelines (JOGMEC, 2023), many GHG emissions calculations do not incorporate direct measurement but rely on secondary data, multiplying activity levels with standard emission factors. Whilst using secondary data is more straightforward, it may not accurately reflect actual operating conditions, leading to potential misrepresentation of a project's emissions.

In 2023, an OGMP 2.0 member company in the US compared methane emissions reported at Level 3 (general emission factors) and Level 4 (asset-specific methods using measurements and simulations) (IMEO, 2023). The findings revealed that Level 4 emissions were 2.3 times higher than Level 3 estimates, with significant differences in source attribution.

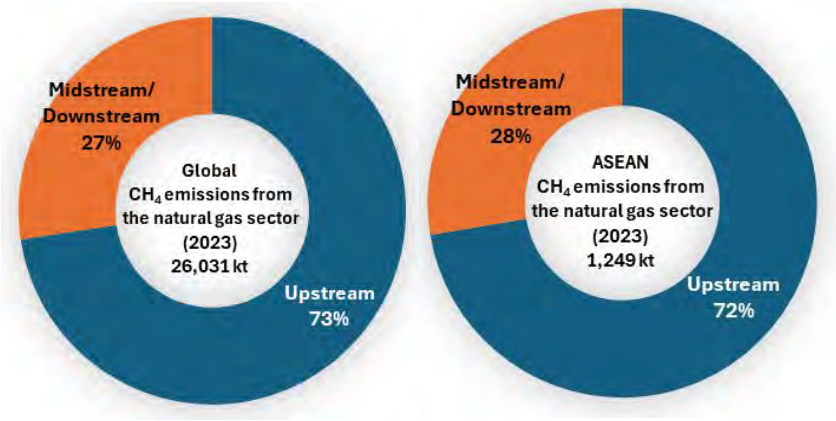
There is a growing requirement for direct measurements of methane emissions to improve transparency and accuracy. Initiatives such as OGMP mandate reporting by source, incorporating some actual on-site measurements in emissions calculations.

4. Methane Emissions from the LNG Value Chain

Globally, methane emissions from the natural gas industry are primarily generated in the upstream sector, which accounts for 73% of total emissions, whilst the midstream and downstream sectors contribute the remaining 27%, according to the IEA. In ASEAN, these figures are slightly different, with the upstream sector responsible for 72% of methane emissions, and the midstream and downstream sectors making up for 28% (Figure 1.5).

A study by Cheniere (2021) compared production-to-regasification CO_2 emissions (with methane converted to CO_2 equivalent) for the United Kingdom (UK) (European market) and China (Asian market). The study found that regasification emissions comprised around 1% of total emissions in the UK and 0.7% in China.Error! Reference source not found.

Figure 1.5. Composition of Methane Emissions in the Natural Gas Sector (World, ASEAN) (2023)



ASEAN = Association of Southeast Asian Nations, CH_4 = methane, kt = kilotonne.
Note: Some data are not applicable.
Source: Compiled from the IEA Methane Tracker 2024.

5. Summary of Methane Emissions

The methane emissions reported by companies to the UNFCCC and OGMP 2.0 are significantly lower than the IEA's Global Methane Tracker estimates, suggesting that underestimation of emission factors and unreported or unknown methane sources may be contributing factors. To address these issues, there is an urgent need for transparent data collection through direct measurements. Technological advancements, such as the

use of satellites, have increased the quality of data, and the trend towards improving data accuracy is expected to continue.

Most methane emissions in the LNG value chain occur upstream. If natural gas is to remain a key clean energy source, it is essential to reduce methane emissions, particularly from upstream. ASEAN, the world's fourth-largest LNG exporter, is also the fourth-largest methane emitter after China, the US, and India, according to the IEA. Therefore, methane reductions in ASEAN could have a significant global impact.

The combined methane emissions of the top-three ASEAN countries in the natural gas sector—Indonesia, Thailand, and Malaysia—were around 1 million tonnes per year as of 2023, according to the IEA's Methane Tracker. A 40% reduction in these emissions, which the IEA notes is achievable at zero net cost globally, could free up an additional 0.4 million tonnes of natural gas annually. This amount would be equivalent to 2%–3% of ASEAN's LNG imports as of 2023. Thus, reducing methane emissions could play an important role in strengthening ASEAN's energy security.

Indonesia, Thailand, and Malaysia are also the region's largest natural gas producers. Malaysia has shown success in methane management, with relatively low emissions despite being the largest producer and consumer of natural gas in ASEAN. Indonesia also made significant progress in 2023, reducing methane emissions in its energy sector by 39.9% compared with the previous year. It is anticipated that other ASEAN countries will follow Malaysia and Indonesia's lead in implementing methane emission management initiatives.

As LNG imports continue to rise in Thailand, Singapore, and other countries, and as the Philippines and Viet Nam begin importing LNG, natural gas consumption is expected to increase during the energy transition. This makes methane emission management a key priority for the region.

Chapter 2

Policies for Methane Emission Management

1. COP28 Dubai Side Events on Methane Emission Mitigation Actions

During the 28th United Nations Climate Change Conference or Conference of the Parties (COP28), held in Dubai, United Arab Emirates, from 30 November to 12 December 2023, several events focused on methane reduction actions were organised. This section summarises the key side events related to methane reduction that were held in the Blue Zone Area of COP28. Table 2.1 lists the main events, with a detailed discussion of each event outlined in the following subsections.

Table 2.1. Major Methane Mitigation Side Events at COP28 Blue Zone

Theme	Organisers	Date (d/m/yyyy)
No time to waste: the role of the waste sector in achieving the Global Methane Pledge	World Biogas Association, Institute for Governance and Sustainable Development, International Solid Waste Association	1/12/2023
Methane reduction and environmental justice: recommendations for the Global Methane Pledge	Global Alliance for Incinerator Alternatives Philippines, Inc.; Pesticide Action Network Asia BHD	1/12/2023
Methane Ministerial: Mobilising Action, Financing Solutions, and Achieving Reductions	Clean Air Task Force, Greener Impact International	4/12/2023
Eliminating methane emissions by 2030	UNFCCC COP28 Presidency	5/12/2023
Reducing Global Methane Emissions: Imperatives, Opportunities, and Challenges	Harvard University, Foundation Environment Law Society	6/12/2023
Multi-sector Collaboration: Accelerating Action on Methane and Delivering the Global Methane Pledge	International Gas Union, Clean Resource Innovation Network	6/12/2023
Methane Pledge two years on: working together to pick the low-hanging fruit of mitigation	European Union	10/12/2023

Theme	Organisers	Date (d/m/yyyy)
Satellite Technologies for Measuring and Tracking GHG Emissions	King Abdullah Petroleum Studies and Research Center	10/12/2023
Bursting the methane bubble: Hydropower as a false climate solution	Water Climate Trust and Rios to Rivers	11/12/2023

1.1. No Time to Waste: The Role of the Waste Sector in Achieving the Global Methane Pledge

1.1.1. Event Overview

Theme	No Time to Waste: The Role of the Waste Sector in Achieving the Global Methane Pledge
Organisers	World Biogas Association Institute for Governance and Sustainable Development International Solid Waste Association
Country	International
Date	1 December 2023
Main Speakers	Martina Otto (Head of Secretariat, Climate and Clean Air Coalition), Carlos Silva Filho (President, International Solid Waste Association), Charlotte Morton, Order of British Empire (Chief Executive, World Biogas Association), Robert Dysiewicz (Vice President, Integrated Utilities, Gutteridge Haskins & Davey), Zachary Tofias (Director of Food and Waste, C40 Cities)

1.1.2. Discussion Outline

- This session emphasised the waste sector's crucial role in reducing methane emissions through better organic waste management and recycling, particularly through anaerobic digestion.
- The discussion underscored methane's significant contribution to global warming, accounting for roughly one-third of current warming, with the waste sector being the third largest source.
- Speakers stressed the importance of scaling up organic waste recycling, biogas utilisation, and the adoption of circular economy practices as key strategies to

significantly lower worldwide emissions.

- With more than 150 nations committed to the Global Methane Pledge and formulating national strategies, the event called for stronger partnerships, innovative solutions, and concerted efforts to address the waste management challenges.

1.2. Methane Reduction and Environmental Justice: Recommendations for the Global Methane Pledge

1.2.1. Event Overview

Theme	Methane Reduction and Environmental Justice: Recommendations for the Global Methane Pledge
Organisers	Global Alliance for Incinerator Alternatives Philippines, Inc. Pesticide Action Network Asia BHD
Country	International
Date	1 December 2023
Main Speakers	From Climate and Clean Air Coalition; Global Methane Hub; Global Alliance for Incinerator Alternatives (International); International Alliance of Waste Pickers; Alianza Basura Cero (Ecuador); Pesticide Action Network Asia and the Pacific (Malaysia); Caravan for Food, Land and Climate Justice; Thanal (India); Trivandrum Municipality (India). Christie Keith(US Executive Director, GAIA), Mahesh Pandya (Paryavaran Mitra), Pavel Partha (Director, Barcik), Arnold Padilla (Coordinator, PAN Asia Pacific)

1.2.2. Discussion Outline

- This event focused on integrating environmental justice principles into methane reduction strategies to accelerate mitigation efforts, build public support, and generate additional benefits.
- The speakers advocated for policies supporting agroecology, which can significantly reduce methane emissions by improving soil management and promoting the integration of livestock and farming to create nutrient cycles and reduce reliance on intensive corporate livestock farming.
- The event also shed light on the disproportionally high methane emissions from

waste in developing countries, where women and children often bear the burden of waste disposal. Effective waste management would not only mitigate methane emissions but also protect vulnerable populations from hazardous exposure.

1.3. Methane Ministerial: Mobilising Action, Financing Solutions, and Achieving Reductions

1.3.1. Event Overview

Theme	Methane Ministerial: Mobilising Action, Financing Solutions, and Achieving Reductions
Organisers	Clean Air Task Force, Greener Impact International
Country	United States
Date	04 December 2023
Main Speakers	John Kerry (US Special Presidential Envoy for Climate Change), Frans Timmermans (Executive Vice-president, European Commission), Inger Anderson (Executive Director, United Nations Environment Programme), Maisa Rojas (Minister of Environment, Chile), ministers from Global Methane Pledge countries, civil society representatives, private sector representatives, and philanthropy representatives

1.3.2. Discussion Outline

- This session focused on the Global Methane Pledge, which is driving action across the energy, waste, food, and agriculture sectors to reduce methane emissions. The ministerial meeting reviewed the progress made in country-level implementation, resource mobilisation, and project execution globally to align with the pledge's methane reduction goal.
- Since COP27, over US$1 billion in new grants have been secured for methane reduction initiatives, more than tripling the existing funds. This significant increase in funding, exceeding €920 million, is expected to generate billions of dollars in investment aimed at reducing methane emissions.
- Major oil and gas producers, which are key contributors to methane emissions, have introduced groundbreaking national policies and measures. Additionally, decisive steps are being taken in the waste management, food, and agriculture sectors.
- The introduction of revolutionary data tools, such as the Methane Alert and

Response System and the Data for Methane Action Campaign, marked a significant step forward in methane emissions tracking and response.

- The Global Methane Pledge has expanded its membership, welcoming new countries like Germany, Canada, the Federated States of Micronesia, Japan, and Nigeria, alongside the EU and the US, as leading advocates. New members, including Romania, Turkmenistan, Kazakhstan, Kenya, and Angola, bring the total number of participating governments to 155.
- Achieving the Global Methane Pledge's target of reducing human-caused methane emissions by at least 30% by 2030 (relative to 2020 levels) is crucial for rapidly decreasing short-term warming. This reduction is vital to maintaining the goal of limiting the temperature increase to 1.5°C. Methane is responsible for 30% of the current warming effect and is a precursor to tropospheric ozone, a potent greenhouse gas and air pollutant. Tropospheric ozone is linked to hundreds of thousands of deaths and significant crop losses annually. Swiftly reducing methane emissions is key to addressing global climate change, improving public health, ensuring food security, and bolstering energy security.

John Kerry, US Special Presidential Envoy for Climate Change, delivered the opening address.

1.4. Eliminating Methane Emissions by 2030: Accelerating the Decarbonisation of Oil and Gas

1.4.1. Event Overview

Theme	Eliminating Methane Emissions by 2030
Organiser	UNFCCC COP28 Presidency
Country	International
Date	05 December 2023
Main Speakers	Saamir Elshihabi (Principal Lead, Energy Transition, COP28 Presidency), Dr. Abdulla Malek (Head, Energy Transition, COP28 Presidency), Demetrios Papathanasiou (Global Director, Energy and Extractives Global Practice, World Bank), Vicki Hollub (President and Chief Executive Officer [CEO], Occidental), Peter Abraam (Chief Strategy and Growth Officer, International Holding Company), Musasbbeh Al Kaabi (Executive Director, Low Carbon Solutions & International Growth, ADNOC), Greg Sharenow (Managing Director and Portfolio Manager, Pacific Investment Management Company), Fred Krupp (President, Environmental Defense Fund), Bjørn Otto Sverdrup (Chair, Oil and Gas Climate Initiative Executive Committee), Arun Kumar Singh (CEO, Oil and Natural Gas Corp. Ltd.), Patrick Pouyanne (Chairman of the Board and CEO, TotalEnergies), Oritsemeyiwa Eyesan (Executive Vice President, Upstream, Nigerian National Petroleum Company Ltd.) Myles Allen (Professor, Oxford University), Ricardo Roa Barragan (CEO, Ecopetrol), Farhat Omar Bengdara (Chairman, National Oil Corporation)

1.4.2. Discussion Outline

- This event, hosted by the COP28 Presidency, aimed to accelerate the elimination of methane emissions and the decarbonisation of the oil and gas industry. It brought together key players from oil and gas companies, multilateral development banks, asset management funds, and civil society to explore new financing solutions for methane abatement technologies and provide technical and financial support to oil and gas businesses.
- During the event, cross-border collaborations were announced. TotalEnergies, Petrobras, State Oil Company of the Republic of Azerbaijan, and Sonangol launched joint methane detection and quantification efforts using Airborne Ultralight Spectrometer for Environmental Applications technology across their oil and gas

operations in Brazil, Azerbaijan, and Angola.

1.5. Reducing Global Methane Emissions: Imperatives, Opportunities, and Challenges

1.5.1. Event Overview

Theme	Reducing Global Methane Emissions: Imperatives, Opportunities, and Challenges
Organisers	Harvard University Foundation Environment - Law Society
Country	International
Date	06 December 2023
Main Speakers	Stephen Hammer (Methane Lead, World Bank), Claire Henly (Senior Advisor for non-CO_2 GHGs, US Special Presidential Climate Envoy), Robert Stavins, (Director, Harvard University Methane Initiative), Helena Varkkey (University Malaya and CERAH initiative on methane emissions in Malaysia)

1.5.2. Discussion Outline

- The event outlined the significant role of methane abatement in mitigating climate change and its immediate impacts. It showcased the latest research and practices in technology, policy, highlighting the work of the new Harvard Initiative on Reducing Global Methane Emissions.
- The Harvard initiative aims to collaborate with government bodies, businesses, non-governmental organisations, and international organisations to explore policy interventions and research aimed at tackling methane emissions.
- The speakers emphasised that prioritising methane reduction could provide a crucial window to flatten the CO_2 emissions trajectories, support further carbon mitigation efforts, and facilitate the adoption of comprehensive climate change strategies.

1.6. Multi-sector Collaboration: Accelerating Action on Methane and Delivering the Global Methane Pledge

1.6.1. Event Overview

Theme	Multi-sector Collaboration: Accelerating Action on Methane and Delivering the Global Methane Pledge
Organisers	International Gas Union Clean Resource Innovation Network
Country	International
Date	06 December 2023
Main Speakers	Experts from private and public innovation funders, Canadian indigenous groups, student or youth groups, energy industry executives, policymakers, and clean energy innovators

1.6.2. Discussion Outline

- This session explored the commitments required from the energy sector, innovators, policymakers, and financial institutions to achieve significant methane emission reductions by 2030. The focus was on how these stakeholders can collaborate with Global Methane Pledge signatories to meet net-zero targets.
- The speakers agreed that reducing methane emissions requires new technology and cross-sector cooperation. They emphasised the importance of both financial incentives ('carrots') and frameworks ('sticks') to drive meaningful action.

1.7. Methane Pledge Two Years On: Working Together to Pick the Low-hanging Fruit of Mitigation

1.7.1. Event Overview

Theme	Methane Pledge Two Years On: Working Together to Pick the Low-hanging Fruit of Mitigation
Organiser	European Union
Country	International
Date	10 December 2023
Main Speakers	Maria Spyraki (European Parliament), Catherine Wolfram (Resource for the Future and Massachusetts Institute of Technology), Andris Piebalgs (European University Institute), Kim

	O'Dowd (Environmental Investigation Agency), Jutta Paulus (European Parliament)

1.7.2. Discussion Outline

- This European Union (EU) pavilion event focused on methane mitigation in the energy sector, with particular attention given to the carbon boarder adjustment mechanism for methane emissions.
- Moderator Maria Spyraki provided an overview of methane policy development in the EU, underscoring the recent agreement reached at the European Parliament and Council.
- Andris Piebalgs highlighted the success of the Global Methane Pledge, which now includes around 150 countries and regions, and the ambition demonstrated by the Oil and Gas Decarbonization Charter at COP28. He pointed out that the 50 signatory companies represent 40% of global oil production, with commitments to eliminate routine flaring by 2030 and achieve near-zero methane emissions by 2030.
- Catherine Wolfram proposed that the US and EU agree on a carbon border adjustment mechanism for methane emissions, applying the same methane intensity regulations to imported methane as those opposed domestically in the US. Andris Piebalgs found this proposal interesting and noted that it could be implemented given that US industry is already subject to these regulations.
- Kim O'Dowd, focusing on the Global South, emphasised the importance of three key elements: finance; monitoring, reporting, and verification; and mitigation measures. She emphasised the need for clear guidelines in national mitigation action plans, particularly in the sectors of agriculture and waste management.

1.8. Satellite Technologies for Measuring and Tracking Greenhouse Gas Emissions

1.8.1. Event Overview

Theme	Satellite Technologies for Measuring and Tracking GHG Emissions
Organiser	King Abdullah Petroleum Studies and Research Centre
Country	Saudi Arabia
Date	10 December 2023
Main Speakers	Anwar Gasim, Antoine Halff, Kayrros, Walid Mater Abdelrahman, Muhsen (King Abdullah Petroleum Studies and Research Centre)

1.8.2. Discussion Outline

- This event, held at the Industry Pavilion, introduced the 'Satellite Technologies for Measuring and Tracking GHG Emission', the latest report of the King Abdullah Petroleum Studies and Research Centre (KAPSARC).
- In collaboration with Kayrros, a leading environmental intelligence company, KAPSARC analysed emissions of three primary GHGs in Saudi Arabia: methane, CO_2, and N_2O.
- The findings revealed that methane emissions from oil and gas fields, as measured by satellite in 2021 and 2022, were nearly double the figures reported by the Saudi government to the United Nations Framework Convention on Climate Change in 2016.
- The report concluded that a comprehensive approach using bottom-up methods, ground-based remote sensing platforms, and top-down airborne and satellite techniques would enhance the transparency, accuracy, and timeliness of emissions data.

1.9. Hydropower as a False Climate Solution

1.9.1. Event Overview

Theme	Hydropower as a False Climate Solution
Organisers	Water Climate Trust, Rios to Rivers
Country	International
Date	11 December 2023
Main Speakers	Thomas Joseph (Indigenous Environmental Network), Mark Easter (Save the Colorado), Mayalmit Lepcha (Affected Citizens of Teesta), Emmanuel Musuyu (Coalition of Civil Society Organisations for the Monitoring of Reforms and Public Action), Ayesha D'Souza (International Rivers)

1.9.2. Discussion Outline

- This official side event examined the significant methane emissions associated with large-scale hydropower, the United Nations' support for dams as emission offsets, and the growing risks that the climate crisis poses to dam infrastructure and downstream communities. Indigenous-led efforts to restore rivers through dam removal were also discussed.
- Thomas Joseph presented research indicating that large-scale dams can be as

environmentally harmful as fossil fuels when considering the full life-cycle of GHG emissions.

①. During construction: CO_2 emissions arise from cement production and deforestation.
②. During operation (over 100 years): Methane emissions are released from water surfaces, CO_2 and N_2O are emitted from wetlands.
③. During decommissioning: Methane is released from exposed sediments, whilst CO_2 is emitted during deconstruction work.

- The discussion also stressed the need for advanced airborne and space-based sensors to detect and quantify methane emissions from reservoirs.

2. Policies and Regulations Outside of ASEAN

Methane emissions reduction policies in Australia, Canada, China, the EU, India, Korea, and the US are at various stages of implementation, ranging from planning stages to full execution. Table shows these policies.

Table 2.2. Methane Emissions Reductions Policies by Country

	Plan/Roadmap	Under planning		Introduced	
		Regulation, reporting obligation, penalty, etc.	Incentive	Regulation, reporting obligation, penalty, etc.	Incentive
Australia				- Safeguard Mechanism Reforms, March 2023	
Canada		- **Proposed Amendments to the Federal methane Regulations for the Oil and Gas Sector, December 2024** - Proposed Regulatory Framework for an Oil and Gas Sector Greenhouse Gas Emissions Cap, December 2023			
China	- Methane Emissions Control Plan, November 2023				
EU				- **Regulation on methane emissions reduction in the energy sector, May 2024**	
India	- Measures to Reduce methane Emissions, July 2023				
Korea	- 2030 Methane Emissions Reduction Roadmap, November 2023				
US		- Waste Emissions Charge, January 2024		- **Final Rule to Reduce Methane and Other Pollution from Oil and Natural Gas Operations, March 2024** - Final Rule: Greenhouse Gas Reporting Rule: Revisions and Confidentiality Determinations for Petroleum and Natural Gas Systems	- Financial and Technical Assistance

EU = European Union, US = United States.
Source: Author.

The EU, the US, and Australia are leading in methane emissions regulation, with Canada closely following, although Australia's safeguard mechanism does not solely focus on methane emissions. In contrast, China, India, and the Republic of Korea are still in the early stages of developing similar frameworks.

Common elements in the regulatory approaches of the EU, the US, and Canada include 1) leak detection and repair and 2) elimination of routine flaring and ventilation. However, each region has distinct features. The US, for instance, has introduced the Super-Emitter Program, whilst the EU has placed specific requirements on imported oil, gas, and coal. These commonalities and distinctive approaches are described in the following subsections.

2.1. Trends in the United States

On 2 December 2023, the US Environmental Protection Agency (EPA) issued a final rule aimed at reducing methane emissions and other air pollutants from oil and natural gas operations. The final rule was published in the *Federal Register* on 8 March 2024, following a supplemental proposal made on 11 November 2022. This rule phases out routine natural gas flaring from new oil wells and requires regular leak monitoring at well sites and compressor stations. It also provides flexibility for companies to adopt innovative, cost-effective methane detection technologies.

A key aspect of the rule is the Super-Emitter Program, which leverages third-party expertise to detect large methane leaks. Under this programme, third parties report their findings to EPA, which then notifies the facility owners and operators. Upon notification, owners and operators are required to investigate the source of the leak, report their findings, and repair any issues in compliance with EPA standards.

Table 2.3 shows the changes and adjustments made since the November 2022 proposal. In relation to the Super-Emitter Program, the initial proposal allowed qualified third parties to directly notify owners and operators of regulated facilities upon detection of a super-emitting event. The final rule introduces important changes, including industry-suggested features, to strengthen the EPA's oversight role. Under the revised rule, the EPA will now be responsible for receiving and evaluating data submitted by third parties and issuing notifications to the relevant facility owners and operators.

Table 2.3. Changes and Adjustments Made by the United States Since the November 2022 Proposal

	Adjustments and changes since the November 2022 Proposal
Provide industry with the time and flexibility needed to cost-effectively meet them	• The rule provides a two-year phase-in period for eliminating routine flaring of natural gas that is emitted from new oil wells. • The rule provides a one-year phase-in for zero-emissions standards for new process controllers (pneumatic controllers) and most new pumps outside of Alaska. • Where replacement components or parts required for leak repair cannot be obtained and installed by the repair deadline, the rule allows owners and operators additional time to repair leaks at well sites, centralized production facilities, and compressor stations. • Sources constructed prior to December 6, 2022 will be considered existing sources and will have later compliance dates under state plans.
Super-Emitter Program	• The final rule provides a strong oversight role for EPA. EPA will certify third parties, will receive and evaluate the data the third parties provide, and send notifications to owners and operators.
Requirements for state plans for existing sources.	• The final rule provides states additional time to submit plans for reducing emissions from existing sources, with plans due 24 months after the effective date of the rule. The final rule generally requires that state plans require compliance by no later than 36 months after the plans are due to EPA. This means that existing sources could have up to 5 years after the effective date of EPA's final rule before they must comply with requirements in state plans.

Source: EPA (2024).

The Inflation Reduction Act introduced new powers under Section 136 of the Clean Air Act to address methane emissions in the petroleum and natural gas sectors through the creation of the Methane Emissions Reduction Program, as detailed in the previous year's report. This programme 1) provides more than US$1 billion in financial and technical assistance through multiple funding opportunities, 2) establishes a waste emissions charge for methane, and 3) requires EPA to update the Greenhouse Gas Reporting Program subpart W regulations for the oil and gas sector.

Table 2.4 shows the progress in implementing the Methane Emissions Reduction Program to date.

Table 2.4. Implementation of the Methane Emissions Reduction Programme

		Source
Financial and Technical Assistance CAA Section 136(a)-(b)	• On December 15, 2023, EPA and DOE announced a conditional commitment to 14 states to receive a total of $350 million in formula grant funding to help measure and reduce methane emissions from the oil and gas sector. • On June 21, 2024, EPA and DOE announced that application are open for $850 million in federal funding for projects that will help monitor, measure, quantify an reduce methane emissions from the oil and gas sectors.	EPA, Financial and Technical Assistance from the Methane Emissions Reduction Program, Retrieved on June 30, 2024. https://www.epa.gov/inflation-reduction-act/financial-and-technical-assistance-methane-emissions-reduction-program.
Waste Emissions Charge (WEC) Proposed Rule: Waste Emissions Charge for Petroleum and Natural Gas Systems on 12 January 2024 CAA Section 136(c)-(g)	• **Calculation procedures**: methodologies for calculating the amount by which a facility's reported methane emissions are below or in exceedance of the waste emissions threshold • **Exemptions**: approaches for implementing the three exemptions: Unreasonable Delay, Plugged Wells, and Regulatory Compliance • **Reporting requirements**: owners or operators of applicable facilities would be required to submit a WEC filing for **the 2024 reporting year by March 31, 2025**.	EPA, 2024, Waste Emissions Charge for Petroleum and Natural Gas System. https://www.govinfo.gov/content/pkg/FR-2024-01-26/pdf/2024-00938.pdf, published in the Federal Register on 26 January 2024.
GHGRP Subpart W Final Rule: Greenhouse Gas Reporting Rule: Revisions and Confidentiality Determinations for Petroleum and Natural Gas Systems on 6 May 2024 CAA Section 136(h)	• Add new or revise existing calculation methodologies to improve the accuracy of emissions data reported to GHGRP, incorporate additional empirical data, and allow owners and operators of applicable facilities to submit empirical emission data. • Include previously unreported sources such as other large release events; allow the use of advanced technologies (e.g. aircraft or satellite measurement) to help and quantify large release events. • Data will be collected at the level of individual well pad sites and gathering boosting sites for onshore production and gathering and boosting facilities, respectively, to improve verification and transparency of the data reported. • Technical amendments, corrections, and clarifications. • Most of the revisions would become effective on January 1, 2025, and that reporters would implement the majority of the changes beginning with reports prepared for **the 2025 reporting year and submitted by March 31, 2026**.	EPA, 2024, Greenhouse Gas Reporting Rule: Revisions and Confidentiality Determinations for Petroleum and Natural Gas System. https://www.govinfo.gov/content/pkg/FR-2024-05-14/pdf/2024-08988.pdf, published in the Federal Register on 14 May 2024.

Sources: Indicated in the table.

Regarding financial and technical assistance, on 15 December 2023, EPA and the US Department of Energy (DOE) announced a conditional commitment to 14 states, providing a total of US$350 million in formula grant funding to support the measurement and reduction of methane emissions in the oil and gas sector. Furthermore, on 21 June 2024, EPA and DOE announced the opening of applications for an additional US$850 million in federal funding, aimed at projects that will help monitor, measure, quantify, and reduce methane emissions in this sector.

On 12 January 2024, EPA announced a proposed rule for a waste emissions charge applicable to petroleum and natural gas systems. Then on 6 May 2024, EPA released a final rule to strengthen, expand, and update methane emissions reporting requirements for these systems, with the rule published in the *Federal Register* on 14 May 2024.

2.2. Trends in the European Union

On 15 November 2023, the European Parliament and the Council of the EU reached a provisional political agreement on a regulation to reduce methane emissions in the energy sector. The regulation was formally adopted by the European Parliament on 10

April 2024 and by the Council of the EU on 27 May 2024.

Under the new rules, operators must detect and repair methane leaks. They are required to conduct methane leak surveys on different types of infrastructure at specified intervals. Once a leak surpassing set methane thresholds is detected, operators must repair or replace the faulty components immediately, or within a maximum of 5 days. Full repairs must be completed within 30 days. In addition, the regulation bans venting and flaring of methane at drainage stations by 2025, and at ventilation shafts by 2027, except in cases of emergency or malfunction where it is strictly necessary.

The regulation also sets requirements for imported oil, gas, and coal, with three implementation phases outlined in Table 2.5. The first phase focuses on data collection. By 1 January 2027, the second phase mandates exporters to the EU to apply equivalent monitoring, reporting, and verification measures. Finally, by 2023, the third phase introduced maximum methane intensity values for imported products.

Table 2.5. The European Union's Timeline for 'Chapter 5 Methane Emissions from Crude Oil, Natural Gas, and Coal Placed on the Union' Under the Regulation on Methane Emissions Reduction in the Energy Sector

Time after the date of entry into force of the Regulation	Chapter 5 Methane emissions of crude oil, natural gas and coal placed on the Union	Article and paragraph
9 months	Importers shall provide **the information** to the competent authorities of the Member State.	Article 27 (1): Requirements applying to importes
1 January 2027	Importers shall demonstrate, and report to the competent authority of the Member State that the contracts concluded or renewed on and after [the date of entry into force of this Regulation] for the supply of crude oil, natural gas or coal produced outside the Union cover only crude oil, natural gas or coal that is subject to **monitoring, reporting and verification measures** applied at the level of the producer that are **equivalent** to those set out in this Regulation.	Article 28 (1): Equivalence of monitoring, reporting and verification measures
Three years	The Commission shall adopt a delegated act by setting out **the methodology for calculating**, at the level of the producer, **the methane intensity** of the production of crude oil, natural gas and coal placed on the Union market.	Article 29 (4): Methane intensity of the production of crude oil, natural gas and coal
Four years	Union producers and importers shall report to the competent authority of the Member State **the methane intensity** of the production of crude oil, natural gas and coal placed on the Union market.	Article 29 (1)
Five years	The Commission shall assess the potential impact of various levels of **maximum methane intensity values** associated with crude oil, natural gas and coal placed on the Union market at the level of the producer, and present a report to the European Parliament and the Council.	Article 29 (5)
	On the basis of the assessment, the Commission shall adopt delegated acts by setting out **the maximum methane intensity values** associated with the crude oil, natural gas and coal placed on the Union market at the level of the producer.	Article 29 (6)
Six years	Union producers and importers shall demonstrate to the competent authorities of the Member State that the methane intensity of the production of the crude oil, natural gas and coal they placed on the Union market is below **the maximum methane intensity values**.	Article 29 (2)

Source: European Parliament and the Council of the European Union (2024).

2.3. Trends in Canada

On 4 December 2023, Canada introduced enhanced regulations for methane emissions in the oil and gas sector. These new regulations, building on the proposed framework from November 2022, aim to eliminate routine venting and flaring, improve leak detection and repair practices, and address problems such as blowdowns and other potentially large-scale methane releases (Table 2.6). Canada's approach is broadly aligned with that of the US in both form and rigour.

Table 2.6. Canada's Proposed Amendments to the Federal Methane Regulations for the Oil and Gas Sector

		• The proposed Regulatory amendments are intended to ensure a reduction of methane emissions in the upstream oil and gas sector by at least 75 per cent below 2012 levels by 2030.
Regulatory approach	Venting Emissions	• The proposed amendments would prohibit the venting of hydrocarbon gas to the environment with limited exceptions. • Starting in 2027, facilities increasing gas production would need to design and operate systems to eliminate venting and to follow other new requirements such as limits on flaring.
	Emissions Associated with Combustion of Hydrocarbon Gas	• Combustion systems used to comply with the proposed Amendments must operate with a pilot flame, an automatic ignition device and an automatic flame failure detection system, and when hydrocarbon gas is routed to the system, it must achieve a minimum carbon conversion efficiency of 98 percent.
	Flaring	• Flaring must be supported by an engineering study examining options for the use of hydrocarbon gas to produce useful heat or energy.
	Fugitive Emissions	• The proposed amendments introduce a risk-based approach to fugitive emissions management. Upon detection of emissions, the permitted repair timeline would be emissions rate-dependent, with the possibility of extensions. • The requirements related to managing fugitive emissions would come into force for all facilities in 2027.
Performance based approach		• This proposed measure sets out an alternative pathway for compliance and includes a performance standard that would rely on the installation of continuous monitoring systems to monitor the facility's potential methane emission sources.
		• All facilities in the oil and gas sector would be subject to the new requirements in 2030.

Source: Government of Canada, Department of the Environment and Department of Health (2023).Error! Reference source not found.

On 7 December 2023, Canada also proposed the Regulatory Framework for an Oil and Gas Sector Greenhouse Gas Emissions Cap (Table 2.7). This emissions cap is a key component of Canada's 2030 Emissions Reduction Plan, released in March 2022. The plan serves as a sector-specific road map aimed at reducing emissions by 40%–45% from 2005 levels.

Table 2.7. Canada's Proposed Regulatory Framework for an Oil and Gas Sector Greenhouse Gas Emissions Cap

A national cap-and-trade system for oil and gas emissions	• The Government plans to implement a national cap-and-trade system for oil and gas emissions. • The cap-and-trade system for oil and gas emissions will be applied through regulations under the Canadian Environmental Protection Act, 1999 (CEPA).
Who will be included in the cap-and-trade system for oil and gas emissions	• The cap-and-trade system will apply to liquified natural gas (LNG) producers and the upstream subsector. • The greenhouse gases covered would include carbon dioxide, methane, nitrous oxide, and others.

The emissions cap	• The emissions cap will be phased-in between 2026 and 2030.
	• Allowances will be distributed to facilities free of charge, initially.
	
	• The 2030 emissions cap level will be in the range of 106 to 112 million tonnes (Mt) of greenhouse gas emissions. That level is 35 percent to 38 percent below 2019 emission levels.
	• By 2030, the covered parts of the sector should be able to reduce emissions to 131 to 137 Mt, or about 20 percent to 23 percent below 2019 emission levels.
	
	• Facilities will be able to use two types of compliance options:
	  • Offset credits from Canada's Greenhouse Gas Offset Credit System and from provincial systems;
	  • Contributions of a specified amount per tonne to a decarbonization fund.

When the cap-and-trade system will apply	• In mid-2024, the Government plans to publish the proposed cap-and-trade regulations for oil and gas emissions for public comment. • Publication of the final regulations is targeted for 2025. • The first reporting obligations starting as early as 2026. • The start date of the first compliance period will begin between 2026 and 2030.

Source: Environment and Climate Change Canada (2023).

2.4. Trends in China

On 7 November 2023, China unveiled its Methane Emissions Control Action Plan. Whilst the energy-related part of the plan is shown in Table 2.8, it notably lacks specific targets for reducing methane emissions. The plan was released shortly after a climate meeting between China and the US, following China's commitment at COP26 in Glasgow to cooperate with the US on methane measurement and reduction. However, China has not yet joined the Global Methane Pledge.

Table 2.8. China's Methane Emissions Control Action Plan

II. Overall requirements		
	(3) Major objectives	**During the "14th Five-Year Plan" period**, methane emission control policy, technology and standard systems will be **gradually established**; basic capabilities such as methane emission statistics and accounting, monitoring and supervision will be **effectively improved**; **and methane resource utilization and emission control work will make positive progress**. **During the "15th Five-Year Plan" period**, methane emission control policy, technology and standard systems will be **further improved**; basic capabilities such as methane emission statistics and accounting, monitoring and supervision will be **significantly improved**; and **methane emission control capabilities and management levels will be effectively improved**. The utilization level of coal mine gas will be further improved. Thereafter, the oil and gas extraction industry will strive to gradually achieve zero routine flaring for onshore oil and gas extraction.
III. Key tasks		
	(2) Promote methane emission control in the energy sector	
		4. Strengthen the comprehensive utilization of methane: By 2025, the annual utilization of coal mine gas will reach **6 billion cubic meters**; by 2030, the collection rate of oilfield associated gas will reach the internationally advanced level.
		5. Promote the application of leak detection and repair technology
		6. Promote the phasedown of routine flaring in oil and gas systems

Source: Ministry of Ecology and Environment (2023).

2.5. Trends in the Republic of Korea

The Republic of Korea formulated its 2030 Methane Emissions Reduction Roadmap, which was submitted to the Global Methane Pledge on 23 November 2023. The plan includes specific methane emissions reduction targets by sector, alongside 14 policy tasks in four sectors.

Table 2.9. Republic of Korea's 2030 Methane Emissions Reduction Roadmap

	Sector	Target/policy task
Reduction targets by sector by 2030 from 2020 levels	Agriculture and livestock sector	34.2 percent
	Waste sector	49 percent
	Energy sector	22.7 percent
14 policy tasks	1. Agriculture and livestock	
	2. Waste	
	3. Energy	• Periodically formulate the 'Fugitive Emissions Management Plan'
		• Reduce fossil fuel use through a transition of the energy mix and a reduction in energy use
		• Improve energy demand efficiency and reduce energy usage
	4. Implementation base	

Source: Republic of Korea (2023).

2.6. Trends in India

India's Ongoing Measures to Reduce Methane Emissions were released by the Ministry of Environment, Forest and Climate Change on 24 July 2024 (Table 2.10). These measures mainly target the country's two predominant sources of methane emissions: enteric fermentation and paddy cultivation. In response to a written question posed in Lok Sabha (the lower house of Parliament), the minister of environment, forest and climate change explained India's reasons for not signing the Global Methane Pledge. The minister highlighted concerns that the pledge shifts the burden of CO_2 reduction to methane, potentially threatening the livelihoods of small, marginal, and medium-sized farmers. On 7 August 2023, the minister provided further details on India's ongoing strategies to curb methane emissions and explore its potential for energy generation.

Table 2.10. India's Ongoing Measures to Reduce Methane Emissions

The National Mission on Sustainable Agriculture	
National Innovations in Climate Resilient Agriculture	System for Rice Intensification
	Direct Seeded Rice
	Crop Diversification Programme
Capacity building programmes through Krishi Vigyan Kendras	
National Livestock Mission	Breed improvement and Balanced Rationing
	Green fodder production, silage making, chaff cutting, and total mixed ration
'The Gobar (Galvanizing Organic Bio-Agro Resources)-Dhan' scheme and New National Biogas and Organic Manure Programme	

Source: Ministry of Environment, Forest and Climate Change (2023)Error! Reference source not found. and Government of India, Ministry of Environment, Forest and Climate Change (2023).

Chapter 3

Initiatives and Frameworks for Methane Emission Management

Methane emission management has become a key issue for countries, industrial organisations, and companies worldwide. Several global and regional initiatives and frameworks have been introduced to address this issue. This chapter provides an overview of the main initiatives and frameworks, detailing their objectives, guidelines, and memberships. In addition, the global trends, desired directions, and challenges identified through these initiatives are summarised.

1. Government-to-Government Initiatives for Methane Emission Management

(i) Global Methane Pledge

In September 2021, the US White House announced the Global Methane Pledge (GMP, 2021) at the Major Economies Forum on Energy and Climate, aiming to reduce global methane emissions by at least 30% from 2020 levels by 2030. At the second Quadrilateral Security Dialogue summit meeting in the US, Japan pledged its participation. By November 2021, at COP26 in the UK, 103 countries, along with the US and the EU, officially launched the GMP to reduce global methane emissions. By COP28 in December 2023, membership had expanded to 155, with 158 countries on board by March 2024.

The GMP focuses on six key action areas: methane plans and policies, finance for methane abatement, data for methane action and for energy, waste, and food and agriculture pathways. The main activities in the oil and gas sector after COP 27 include the following:

Methane plans and policies. Eighty-six governments and the EU are engaged in methane action planning. The Climate and Clean Air Coalition (CCAC) supports GMP countries in developing national methane emission management plans with a transparent and harmonised methodology. Fifty-seven governments and the EU, covering more than 55% of global anthropogenic methane emissions, have developed or are developing these plans, with 31 of them supported by the CCAC. Countries with high methane emissions from the oil and gas sector, such as the US, Canada, and Nigeria, have announced new policies, regulations, and national commitments to cut fossil fuel-origin methane emissions.

Finance for methane abatement. Since COP27, more than US$1 billion in grants has been raised, supported by countries such as the US, members of the EU, the United Arab Emirates, Japan, and Canada, as well as the private sector. The funds aim to cut methane emissions, particularly in low- and middle-income countries.

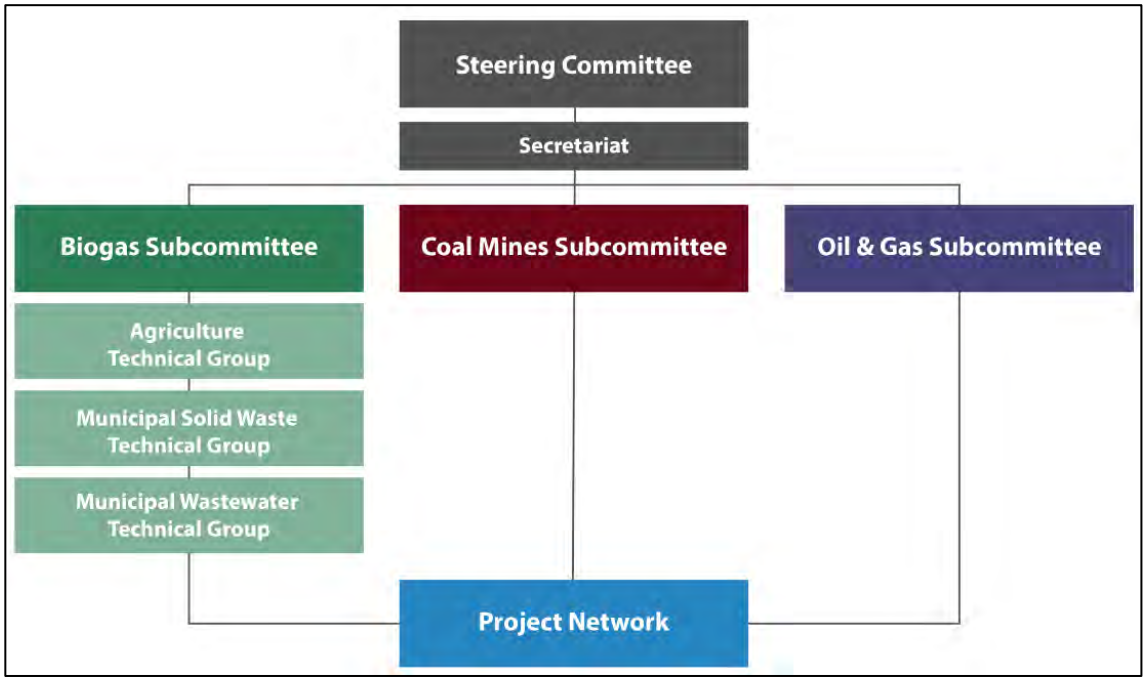
Data for methane action. The International Methane Emissions Observatory (IMEO) Methane Alert and Response System (MARS) and Methane Data Platform integrating data from dozens of public earthobserving satellites. MARS is the first global system to connect satellite-detected methane emissions from oil and gas facilities with a notification process to their related governments and operators.

Energy pathways. The World Bank's Global Flaring and Methane Reduction Partnership supports oil and gas methane and flaring reduction in developing countries, aiming for zero routine flaring and near-zero methane emissions by 2030.

(ii) Global Methane Initiative

Launched in 2004, The Global Methane Initiative (GMI) is a public–private partnership aimed at reducing methane emissions cost-effectively (GMI, 2024). It promotes methane abatement and recovery as an energy source in biogas (including agriculture, municipal solid waste, and wastewater), coal mines, and oil and gas systems. As of March 2024, the GMI had 47 partner countries, including four ASEAN members.

Figure 3.1. Global Methane Initiative Structure and Organisation



Source: Global Methane Initiative.

The GMI operates through a steering committee, three technical subcommittees (biogas, coal mines, and oil and gas), a project network, and a secretariat, all working together to promote project development and encourage active private sector engagement. The technical subcommittees have developed action plans identifying global needs, opportunities, and priorities for project development, as well as key barriers and strategies to address them. They also facilitate investment, financing opportunities, and collaboration on projects aimed at methane abatement, recovery, and its use as an energy source. The project network comprises more than 700 members, including industry leaders, financial institutions, local governments, and experts. These members actively participate in developing subcommittee action plans, capacity-building initiatives, technology transfer, and other activities, sharing their technical expertise, experience, and financial resources.

In February 2024, the GMI launched the GMI Policymaker Framework for Addressing Methane Emission (GMI, 2024). This framework is designed to guide energy and environmental policymakers in systematically addressing methane emissions and accelerating progress towards national or subnational methane emissions reduction goals. It presents a step-by-step process for developing and implementing policies and programmes to measure and reduce methane emissions across entire economies or within specific high-emitting sectors.

(iii) Measurement, Monitoring, Reporting, and Verification Working Group

On 15 November 2023, 13 countries exporting and importing natural gas and LNG, the European Commission, and the East Mediterranean Gas Forum launched an international working group to develop a unified framework for the measurement, monitoring, reporting, and verification of methane, CO_2, and other greenhouse gas emissions across the entire natural gas supply chain (US Department of Energy, 2023). This includes production, processing, transmission, liquefaction, transport, and distribution.

Currently, there is no widely accepted standard for companies to credibly account for and verify their greenhouse gas emissions related to natural gas. This lack of standardisation limits buyers' ability to demand emission reductions from producers and prevents sellers from competing on the basis of a lower greenhouse gas profile. The working group's goal is to develop a transparent and credible framework that enables suppliers, buyers, investors, and policymakers to access the necessary information to drive sustained reductions in GHG emissions throughout the international natural gas supply chain. Throughout 2024 and 2025, the group will focus on several key areas:

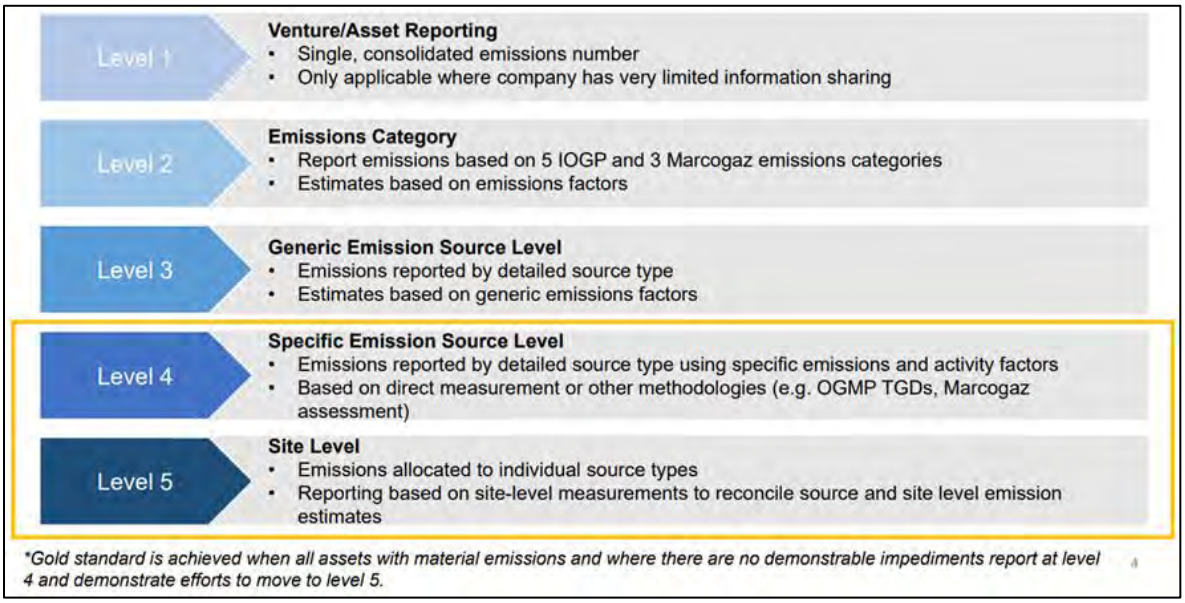
- ✓ Common criteria. Establishing rigorous standards for quantifying and reporting GHG emissions, and developing a process for independent certification or verification of emissions data and compliance with these criteria.
- ✓ Data transparency and tools. Defining expectations for data collection and reporting to meet the needs of natural gas market participants, and developing a transparent and consistent life-cycle analysis tool for calculating and reporting supply chain data quality and GHG emission intensity.
- ✓ Accreditation process. Creating a system to ensure that certifiers follow consistent protocols as identified by the framework, with independent oversight to maintain the credibility of the accreditation process.

2. Company Initiatives for Methane Emission Management

(i) Oil and Gas Methane Partnership

In November 2020, the Oil and Gas Methane Partnership (OGMP) introduced OGMP 2.0, a framework for the measurement, reporting, and verification of methane emissions. Its predecessor, OGMP 1.0, was launched at the 2014 United Nations (UN) Climate Summit as a voluntary initiative aimed at reducing methane emissions within the oil and gas industry. The latest OGMP framework was developed by the UN Environment Programme (UNEP), the European Commission, the Environmental Defense Fund, and the Climate and Clean Air Coalition. Since OMGP's inception in 2014 with just six companies, membership has grown significantly, reaching 141 partner companies by the end of May 2024, including INPEX Corporation, the first Japanese company to join in November 2023 (INPEX, 2023).

Figure 3.2. Five Levels of Methane Emissions Measurement and Reporting in OGMP 2.0



IOGP = International Association of Oil and Gas Producers, OGMP = Oil and Gas Methane Partnership, TGD = Technical Guidance Document.
Source: United Nations Environment Programme (2021).

OGMP 2.0 classifies emissions measurement and reporting into five levels. Levels 1–3 rely on quantification through emission factors, whilst Levels 4–5 require direct measurements and are known as the Gold Standard. Level 4 requires bottom-up type measurements, such as on-site measurements, whilst Level 5 uses top-down methods like drones and satellites. Although companies must commit to these initiatives upon joining, there is no strict requirement to meet the deadlines for achieving the Gold Standard.

Reporting data is published by sector and source rather than by individual asset. Only methane emissions are covered by the framework, excluding other GHGs like CO_2. The scope is limited to Scope 1 emissions, without covering Scopes 2 and 3. The recommended global warming potential for CO_2-based emissions calculations is 72x–85x. The OGMP 2.0 Technical Guidance Documents have been published, providing specific methodologies for Levels 3 and 4 for major emission sources. However, companies are permitted to adopt alternative methodologies, provided they can demonstrate equivalence to the technical guidance documents.

In March 2021, UNEP, in cooperation with the European Commission, announced the creation of IMEO, which serves as the supervising body for OGMP 2.0 reporting. IMEO's role is to collect data from companies via OGMP reporting, improve the accuracy of emissions estimates, and publish an annual report on the status of methane emissions. At the Group of 20 Summit in October 2021, the launch of the observatory was

confirmed, and the first OGMP 2.0 and IMEO annual report, *IMEO 2021 Report* (UNEP, 2021), was published. In that year, 64 of the 74 member companies (12 upstream, 33 midstream, and 19 downstream) submitted reports. In October 2022, the *IMEO 2022 Report* (UNEP, 2022) showed 13 new member companies (10 upstream, 3 midstream/downstream), with 36% of upstream, 56% of midstream, and 10% of downstream companies achieving Level 4 (Gold Standard) reporting—an improvement from the previous year. By December 2023, the *IMEO 2023 Report* (UNEP, 2023) revealed that 14 new member companies (12 upstream, 2 midstream) had joined, and 84 out of a total of 92 companies had met the Gold Standard.

(ii) Oil and Gas Climate Initiative

The Oil and Gas Climate Initiative (OGCI) is a voluntary initiative by the upstream oil and gas sector, aimed at accelerating coordinated action on climate change. Announced in January 2014 at the World Economic Forum in Davos, Switzerland, and officially launched at the UN Climate Change Summit in September 2014, the OGCI is composed of 12 member companies, including major oil firms and state-owned companies such as BP, Chevron, and Shell. Collectively, these companies account for about 30% of global oil and gas production.

Figure 3.3. Oil and Gas Climate Initiative Targets for Methane Intensity Reduction

Source: Oil and Gas Climate Initiative (2024).

The OGCI's target is to reduce the average methane intensity in the upstream oil and gas sector from a baseline of 0.30% in 2017 to below 0.20% by 2025. In November 2016, the OGCI established OGCI Climate Investments, a fund committed to investing US$1 billion over 10 years to accelerate the deployment of low-carbon solutions across the energy, industrial, building, and commercial transport sectors. As a result of this effort, OGCI upstream methane intensity had decreased to 0.15% by 2023, surpassing the 2025 target (OGCI, 2024).

Figure 3.4 History of Oil and Gas Climate Initiative's Upstream Methane Intensity Reduction

Source: Oil and Gas Climate Initiative (2024).

In July 2020, OGCI further demonstrated its commitment by joining the Global Gas Flaring Reduction Partnership and the Payne Institute for Public Policy at the Colorado School of Mines. Together, they provided approximately US$1 million in financial and technical assistance to develop the online platform Global Gas Flaring Explorer. This platform offers mapping and visualisation of gas flaring data from oil production sites worldwide, enhancing monitoring efforts for the Zero Routine Flaring by 2030 Initiative, which was proposed by the World Bank in 2015 to end routine flaring by 2030. In June 2022, the US, Germany, and Norway contributed a total of US$4 million (US$1.5 million each from the US and Germany and about US$1 million from Norway) to support the Global Gas Flaring Reduction Partnership.

(iii) Aiming for Zero Methane Emissions Initiative

In March 2022, OGCI launched the Aiming for Zero Methane Emissions Initiative (Aiming for Zero), an industry-led effort to achieve near-zero methane emissions from operated oil and gas assets by 2030. In June 2022, QatarEnergy became the first company outside the original 12 signatories to join, followed by Wintershall DEA, Neptune Energy, and Australia's Woodside Energy later that year. In February 2023, JGC Holdings became the first Japanese company to participate (JGC, 2023). By January 2024, almost 100 companies and organisations had endorsed the initiative (Aiming for Zero, 2024).

(iv) American Petroleum Institute

The American Petroleum Institute (API), the standard-setting organisation for the US oil and natural gas sector, was established in 1919. The API has developed five complementary guidelines for the accounting, reporting, and characterisation of GHG emissions in the oil and gas industry: i) API Compendium, ii) Guidelines, iii) API Template, iv) Sustainability Guidance, and v) Uncertainty Document.

(v) The Environmental Partnership

The Environmental Partnership consists of companies within the US oil and natural gas industry committed to continuously improving the industry's environmental performance. Established in December 2017 by 26 oil and natural gas production companies, the partnership provides six environmental performance programmes for production, processing, and transmission companies to adopt. These programmes include (i) leak detection and repair, (ii) pneumatic controller, (iii) manual liquids unloading, (iv) compressor, (v) pipeline blowdown, and (vi) flare management. Currently, 102 member companies are improving their practices by participating in these programmes and leveraging data from the EPA's Greenhouse Gas Reporting Program.

(vi) Marcogaz

Founded in 1968, Marcogaz serves as the representative body for the European gas industry. In October 2019, Marcogaz published the *Assessment of Methane Emissions for Gas Transmission and Distribution System Operators* as part of its standards guideline. Furthermore, in August 2020, Marcogaz submitted its methane emissions reporting template to the European Committee for Standardization (Comité Européen de Normalisation) to aid the development of a standard for quantifying methane emissions. In October 2020, Marcogaz published guidance on the methane emissions reporting template, which has since been adopted for reporting under the OGMP 2.0 framework.

(vii) Natural Gas Sustainability Initiative

The Natural Gas Sustainability Initiative (NGSI) was launched by the American Gas Association (AGA) and the Edison Electric Institute in collaboration with the investor

community and experts from across the natural gas chain, including upstream, midstream, and downstream companies. The NGSI serves as an overarching framework to recognise and advance innovative, voluntary programmes across the natural gas supply chain. Initially focused on methane emissions, the NGSI introduced the Methane Emissions Intensity Protocol Version 1.0 (AGA, 2021) in February 2021. This version includes five data reporting templates, each tailored to different segments of the natural gas value chain: production, gathering and boosting, processing, transmission and storage, and distribution. The EEI has 70 international electric companies as affiliate members and 250 suppliers and related organisations as associate members, whilst AGA boasts over 200 member companies. These members can disclose their methane emissions intensity on their sustainability webpage.

(viii) International Group of Liquefied Natural Gas Importers Monitoring, Reporting, and Verification and GHG Neutral LNG Framework

Founded in 1971, the International Group of Liquefied Natural Gas Importers (GIIGNL, 2021) is an industry association for LNG importers. In November 2021, it introduced the Monitoring, Reporting, and Verification (MRV) and GHG (Greenhouse Gas) Neutral Framework, which covers all GHG emissions associated with LNG cargo. The guidelines define four categories of Controlled Natural Language common terms: (i) GHG footprint, (ii) GHG offset, (iii) GHG offset with reduction plan, and (iv) GHG neutral. It encourages the measurement of GHG emissions for each cargo. In January 2023, Shell announced that it had delivered LNG from Gorgon LNG in Australia to CPC Corporation in Taiwan, marking the first delivery in accordance with the framework (GIIGNL, 2023).

(ix) Veritas

Veritas is a methane emission measurement and verification initiative led by GTI Energy. Its technical protocols provide companies and countries with methane emissions reduction targets with a consistent approach to measuring and verifying methane emissions. This enables a credible, consistent, transparent, and verifiable methodology. Veritas' technical protocols (Veritas, no date) cover six segments of the natural gas supply chain: production, gathering and boosting, processing, transmission and storage, distribution, and LNG. These technology-neutral protocols form a comprehensive toolbox of technologies designed to accurately measure total emissions. GTI Energy has engaged a diverse group of stakeholders, including academics, environmental non-governmental organisations, companies, investors, policymakers, and vendors to ensure the methodology is widely accepted and adopted. More than 35 companies have partnered with Veritas to shape the development of these protocols.

(x) MiQ

MiQ, established in December 2020 by the Rocky Mountain Institute and SYSTEMIQ, is a third-party auditing organisation focused on methane emissions. It has developed the MiQ Standard, a framework for assessing methane emission management in facilities. The MiQ Standard provides an A–F grading system to evaluate facilities based on three key criteria: methane intensity, company practices, and monitoring technology deployment. A new rating system is scheduled to be completed by 2023. As a recent development, in August 2024, MiQ has certified 20% of US gas production, with its methane standard used to independently certify 18 facilities operated by 11 natural gas producers, including Chesapeake Energy, Repsol, and EQT. In addition, BP's entire US onshore natural gas portfolio has been certified under the MiQ standard (MiQ, 2023).

(xi) Project Canary

Founded in Denver, USA, in 2019, Project Canary is an independent environmental data and software company that collects, analyses, quantifies, and visualizes asset-level environmental risk assessments and emission profiles. As an MRV solution, its Canary SENSE™ Platform integrates a networked sensor canopy, including third-party sensor data and assessment scores, to provide independently verifiable climate attribute data for upstream, midstream, and carbon capture and storage projects. It has been providing independent analysis to major oil and gas companies, including Chevron.Error! Reference source not found. In November 2022, ENGIE Energy Marketing announced plans to develop a framework and marketing platform for sourcing measured sequestrated carbon to establish a new class of differentiated technology-based carbon credits. Project Canary, as an independent data and analysis provider, will reconcile sensing technologies and measure, analyse, and report the environmental attributes of sequestrated carbon to support decarbonisation efforts (Project Canary, 2023).

(xii) Methane Guiding Principles

Launched in 2017, the Methane Guiding Principles partnership supports both industry and government action to reduce methane emissions across the natural gas supply chain. The partnership is built on five methane guiding principles: continually reduce methane emissions, advance strong performance across the gas supply chain, improve accuracy of methane emissions data, advocate sound policy and regulations on methane emissions, and increase transparency. In November 2023, it launched the Advancing Global Methane Reduction (AGMR) initiative, which aims to instigate and accelerate country-level methane emission reductions. AGMR's 50 members are working with governments and industries in 20 countries representing more than 25% of global oil and gas production. This initiative informs methane policies and regulations whilst promoting best practices (Methane Guiding Principles, 2023). Its members include major international oil companies and national oil companies.

(xiii) Zero Routine Flaring by 2030 Initiative

Launched in 2015, the Zero Routine Flaring (ZRF) by 2030 Initiative commits governments and oil companies to ending routine flaring by 2030. It fosters cooperation amongst stakeholders to identify and implement solutions to end routine gas flaring. Endorsing governments and oil companies agree to report annually on their flaring activities and progress towards meeting the initiative's goals. Although voluntary, the initiative's commitments are monitored through various means, including reports from endorsing entities and satellite observations. ZRF endorsers account for approximately 60% of global gas flaring. As of June 2024, the initiative has gained 109 endorsers, including governments and international oil companies all over the world.

(xiv) Oil and Gas Decarbonization Charter

In December 2023, during COP28 in the United Arab Emirates (UAE), the UAE and Saudi Arabia launched the Oil and Gas Decarbonization Charter, a global industry initiative dedicated to speeding up climate action and driving high-scale impact across the oil and gas sectors. Fifty companies, representing more than 40% of global oil production, signed the charter, including national oil companies that account for more than 60% of the signatories—the largest number of national oil companies ever to commit to a decarbonisation initiative. The signatories have committed to achieve net-zero operations by 2050, end routine flaring by 2030, and reach near-zero methane emissions in upstream activities. They also commit to advancing for emissions reductions best practices across the industry.

(xv) Coalition for LNG Emission Abatement toward Net-zero

On 18 July 2023, KOGAS, the largest domestic natural gas supplier in the Republic of Korea, and JERA, the largest domestic power producer in Japan, launched the Coalition for LNG Emission Abatement toward Net-zero (CLEAN) (Ministry of Economy, Trade and Industry, 2023) to reduce methane emissions. The announcement was made at the LNG Producer–Consumer Conference held the same day. At the conference, the governments of Australia, the European Commission, Japan, the Republic of Korea, and the US signed a joint statement emphasising the importance of CLEAN in reducing GHG, particularly methane, throughout the LNG value chain.

CLEAN represents a collaboration between LNG consumers and producers to reduce methane emissions along the entire LNG value chain. With the support of the governments of Japan, the Republic of Korea, the US, and JOGMEC, the initiative aims to improve transparency by engaging in dialogue with LNG producers and promoting best practices to reduce methane emissions. JOGMEC will support CLEAN by providing a platform to share information on methane reduction targets and measures.

This initiative is significant as it marks the first time two of the world's largest LNG importers have jointly requested greater transparency in the GHG profiles of the LNG they import. Its success hinges on broad industry participation and the effective implementation of the initiative. CLEAN is also expected to contribute to the standardisation of MRVs in gas and LNG production.

Figure 3.5. Joint Statement at the Liquefied Natural Gas Producer–Consumer Conference

Source: Ministry of Economy, Trade and Industry (2023).

3. Summary of Methane Emission Management Initiatives and Frameworks

The methane emission management initiatives and frameworks discussed in this report are categorised in Figure 3.6. These initiatives range from national declarations and target-setting to specific measures aimed at reducing methane emissions. Many of them also provide guidelines for measuring and reporting methane emissions, with some third-party certification organisations included under the frameworks that offer these guidelines.

Figure 3.6. Categorisation of Initiatives and Frameworks for Methane Emission Management

Source: The Environmental Partnership (2017), 'Who We Are' https://theenvironmentalpartnership.org/who-we-are/ ; VERITAS (2021), 'About Veritas: A Proving Ground for Emissions Reduction' https://veritas.gti.energy/about; American Petroleum Institute (1919), 'About API' https://www.api.org/about ; Marcogaz (1969), 'Methane Emissions+ (G7)' https://www.marcogaz.org/groups/methane-emissions/ ;MiQ (2021), 'About' https://miq.org/about/#the-team

Table 3.1 summarises the initiatives and frameworks described in this report. More than 150 countries are participating in the GMP, signalling increasing global momentum towards methane emission reductions. Major energy companies, particularly in the upstream sector, are taking steps by joining various frameworks. Similarly, midstream and downstream natural gas companies are participating in industry-wide efforts, including the development of measurement and reporting guidelines by industry associations.

Six ASEAN countries are participating in the GMP and GMI, but participation in other corporate frameworks is currently limited. With both producers and consumers of natural gas involved in the same initiatives and frameworks, there is potential for these efforts to spread geographically and over the entire natural gas supply chain.

Given that many methane emission management frameworks have been established in a brief period, there are a variety of guidelines for measuring and reporting methane emissions, making it difficult to compare data across frameworks or calculate emissions across the entire supply chain. Standardisation and coordination of these guidelines is a critical issue that needs to be addressed in the future. For these guidelines to be widely adopted, a balanced approach is required, one that takes into account the needs of various businesses whilst ensuring operational feasibility in the field.

Table 3.1. Methane Emission Management Initiatives and Frameworks

Initiative and Framework	Numerical Targets	Activity	MRV Guideline	Number of Memberships[a]	
				Total	ASEAN
GMP	Global methane emissions 30% below 2020 levels by 2030	● Annual ministerial meetings to review progress ● Launch of policy and initiative pathways to promote methane emissions reduction	N/A	>150	6
GMI	N/A	● Develop action plans ● Promote investment and other cooperative activities ● Share technical expertise and financial resources	GMI Tools (Bio-sector only)	47	4
MMRV	N/A	● Develop a consistent framework for the production, processing, transmission, liquefaction, transport, and	N/A	15	0

Initiative and Framework	Numerical Targets	Activity	MRV Guideline	Number of Memberships[a]	
				Total	ASEAN
		distribution of natural gas			
OGMP 2.0	N/A	● Updating guidance on methane emission management ● Regular operational meetings and technical workshops	OGMP 2.0 Technical Guidance Document	141	3
OGCI	Methane intensity < 0.20% by 2025	● Share best practices on methane leak detection and removal ● Investments in natural climate solutions, etc.	OGCI Reporting Framework	12	0
Aiming for Zero Methane Emissions Initiative	Near-zero methane emissions by 2030	● All reasonable methane emission controls, including flaring avoidance, leak detection and remediation, etc. ● Report methane emissions annually ● Continuous improvement of measurement, reporting, and verification (MRV)	N/A	40	0
API	N/A	● Innovative facility design ● Improved operational methods and procedures ● Advances in emissions detection and measurement	Compendium of greenhouse gas emissions methodologies	>500	0

Initiative and Framework	Numerical Targets	Activity	MRV Guideline	Number of Memberships[a]	
				Total	ASEAN
		● Improved accuracy of emissions reporting data			
The Environmental Partnership	N/A	● Sharing best practices and new technologies (6 programmes available for leak detection, repair, etc.)	N/A	102	0
Marcogaz	N/A	● Identification and implementation of best practices for methane emission reductions ● Developing and monitoring technology solutions to detect, quantify, report, and mitigate methane emissions	Assessment of methane emissions for gas transmission and distribution systems	29	0
NGSI	N/A	● Develop protocols for measuring and reporting methane emissions throughout the natural gas supply chain	NGSI Methane Emissions Intensity Protocol	>200	0
GIIGNL	N/A	● GHG reporting throughout the LNG value chain	GIIGNL MRV and GHG Neutral LNG Framework	85	4
Veritas	N/A	● Develop technical protocols and widely accepted methodologies for quantifying methane emissions	Veritas protocols	>35	0
MiQ	N/A	● Develop framework for conducting assessments	MiQ Standard	N/A	N/A

Initiative and Framework	Numerical Targets	Activity	MRV Guideline	Number of Memberships[a]	
				Total	ASEAN
		related to methane emission management			
Project Canary	N/A	● Analyse environmental risk assessments and emission profiles	Canary SENSE platform	N/A	N/A
Methane Guiding Principles	N/A	● Reduce methane emissions from the natural gas supply chain	Five Methane Guiding Principles	47	1
Zero Routine Flaring Initiative	End routine flaring not later than 2030	● Facilitate cooperation between all stakeholders so that solutions to ending routine gas flaring can be identified and implemented	N/A	109	3
Oil & Gas Decarbonization Charter	Net-zero operations by 2050, and ending routine flaring by 2030, and near-zero upstream methane emissions.	● Speed up climate action and achieve high-scale impact across the oil and gas sectors	Oil and Gas Decarbonization Charter	50	3
CLEAN	N/A	● Reduce methane emissions in the LNG value chain	N/A	5	0

API = American Petroleum Institute; ASEAN = Association of Southeast Asian Nations; CLEAN = Coalition for LNG Emission Abatement toward Net-zero; GHG = greenhouse gas; GIIGNL = International Group of Liquefied Natural Gas Importers; GMI = Global Methane Initiative; GMP = Global Methane Pledge; LNG = liquefied natural gas; MMR = measurement, monitoring, reporting; MMRV = measurement, monitoring, reporting, and verification; N/A = not available; NGSI = Natural Gas Sustainability Initiative; OGCI = Oil and Gas Climate Initiative; OGMP 2.0 = Oil and Gas Methane Partnership 2.0.

[a] GMP and GMI memberships refer to country participation, whilst others indicate company membership.

Sources: Websites of the initiatives and frameworks for methane emission management.

Chapter 4

Corporate Initiatives on Methane Emission Management

This chapter summarises the main initiatives and frameworks adopted by companies worldwide to manage their methane emissions, along with emission reduction targets. It also describes each company's approach to methane emission management.

1. Improving Transparency

1.1. Setting Emission Reduction Targets and Disclosure of Methane Emissions

Table 4.1 shows the methane emission reduction targets of selected companies worldwide. The specific targets vary by company, although they are all publicly disclosed. European companies often have goals focused on reducing both methane emissions and methane emissions intensity, whilst many Asian companies primarily target overall GHG emission reductions, as shown in a survey of ASEAN companies conducted by the Asia Pacific Energy Research Centre.

Table 4.1. Methane Emission Reduction Targets of Selected Companies Worldwide

Company	Methane Reduction Target
bp	Methane emission intensity below 0.2% by 2025
Shell	Maintain methane emissions intensity of Shell-operated oil and gas assets (including LNG) to below 0.2% and achieve near-zero methane emissions by 2030
TotalEnergies	1. Methane intensity below 0.1% in all operated upstream oil and gas facilities by 2030 2. Reduce methane emissions on volume basis by 50% (2020–2025) and 80% (2020–2030)
Enagás	Reduce methane emissions on volume basis by 45% by 2025 and 60% by 2030 compared to 2015
INPEX	Maintain methane emission intensity at about 0.1%
JAPEX	GHG emissions reduction targets
Tokyo Gas	GHG emissions reduction targets

Company	Methane Reduction Target
PETRONAS	1) Reduce methane emissions on volume basis from the entire PETRONAS Group natural gas value chain by 50% by 2025 from 2019 levels 2) Reduce methane emissions on volume basis from the entire PETRONAS Group natural gas value chain by 70% by 2030 from 2019 levels 3) Reduce methane emissions on volume basis from Malaysia's natural gas value chain by 50% by 2030 from 2019 levels to support the country's Global Methane Pledge
Pavilion Energy	GHG emissions reduction targets
PTT	GHG emissions reduction targets
PERTAMINA	40% reduction in methane emissions from the 2021 baseline

GHG = greenhouse gas, INPEX = International Petroleum Exploration, JAPEX = Japan Petroleum Exploration, LNG = liquefied natural gas, PERTAMINA = PT PERTAMINA, PETRONAS = Petroliam Nasional Berhad, PTT = PTT Public Company
Sources: Company data.

Table 4.2 shows data on the methane emissions and intensities of selected companies worldwide. In recent years, many companies have begun disclosing this information due to the growing importance of methane emission management worldwide. Some companies have refined their reporting processes, breaking down emissions by factor, GHG type, and domestic versus overseas emissions. However, there is still variation in how methane emissions are calculated, indicating a need for standardisation and improved transparency in the future.

Table 4.2. Methane Emissions of Selected Global Companies

Company	Methane Emissions (tonnes)	Methane Intensity (%)
bp	31,000 (2023)	0.05 (2023)
Shell	41,000 (2023)	0.05 (2023)
TotalEnergies	34,000 (2023)	0.11 (2023)
Enagás	1,985 (2023)	-
INPEX	7,160 (2023)	0.05 (2023)
JAPEX	2,369 (FY2022)	-
Tokyo Gas	427 (FY2022)	-
PETRONAS	186,550 (2023)	0.42 (2023)
Pavilion Energy	Only GHG emissions are published	-
PTT	50,948 (2023)	-
PERTAMINA	88,000 (2023)	-

<All abbreviations here, listed alphabetically>.
bp = British Petroleum, INPEX = International Petroleum Exploration, JAPEX = Japan Petroleum Exploration, PERTAMINA = PT PERTAMINA, PETRONAS = Petroliam Nasional Berhad, PTT = PTT Public Company, Shell = Royal Dutch Shell plc,
Source: Compiled from company data.

1.2. Certification

(i) ExxonMobil / BP (MiQ)

In September 2021, ExxonMobil announced that its Poker Lake facilities in the Permian Basin, New Mexico, had received the highest-grade 'A' certification from MiQ for methane emission control in natural gas production (ExxonMobil, 2021). By April 2022, the Permian Basin facilities' production of 200 million cubic feet per day of natural gas had also been awarded MiQ's highest 'A' grade, making ExxonMobil the first company to receive certification for petroleum-associated natural gas production (ExxonMobil, 2022).

In March 2023, BP's US onshore natural gas producer, bpx Energy, announced it had obtained MiQ certification for all its onshore operations in Texas and Louisiana in the U S (BP, 2023).

(ii) Cheniere Energy

In August 2021, Cheniere Energy, based in the US, announced an LNG life-cycle analysis aimed at improving its assessment of GHG emissions. This analysis utilises data specific to Cheniere's LNG supply chain and serves as the basic analysis tool for the company's cargo emissions tags (CE Tags), which provide GHG emissions estimates for each cargo. In April 2022, Cheniere announced its collaboration with midstream natural gas

companies, methane detection technology providers, and research institutions such as Colorado State University. This partnership is focused on quantifying, monitoring, reporting, and verifying GHG emissions throughout its LNG supply chain, using surface-based, mid-air, and drone emissions tracking and monitoring technologies. In October 2022, Cheniere joined the OGMP 2.0 initiative and began issuing CE Tags to buyers, detailing the estimated GHG emissions for each cargo produced.

(iii) QatarEnergy, Pavilion Energy, Chevron

In April 2020, Singapore's Pavilion Energy issued a request for LNG deliveries of up to 2 million tonnes per year over a 5-year period beginning in 2023. This request included a requirement for suppliers to collaborate in establishing and implementing GHG measurement and reporting methods, covering emissions from the wellhead to the unloading terminal. Subsequently, in November 2020, Qatar Petroleum (now QatarEnergy) signed a deal with Pavilion Energy, marking the first long-term LNG deal to include environmental conditions aimed at reducing the carbon footprint of the LNG supply. In November 2021, Pavilion Energy, QatarEnergy, and Chevron announced the development of a quantification and reporting methodology to produce a Statement of GHG Emissions for LNG cargoes. The statement of GHG emissions methodology complements GIIGNL's MRV and GHG Neutral Framework efforts (Pavilion Energy, 2020, 2021). Error! Reference source not found.

2. Initiatives on Methane Emission Management

2.1. Measurement, monitoring, and leak detection and repair

(i) TotalEnergies

In May 2022, TotalEnergies launched a worldwide campaign to detect and quantify methane emissions across all its upstream oil and gas operations, reinforcing its commitment to reducing emissions. The campaign uses Airborne Ultralight Spectrometer for Environmental Applications (AUSEA) technology, developed in collaboration with the French National Research Center for Scientific Research and the University of Reims Champagne Ardenne.Error! Reference source not found.

AUSEA is a small dual sensor mounted on a drone, capable of detecting methane and CO_2 emissions and identifying their source. This cutting-edge technology allows for accurate measurements at all types of industrial facilities, onshore and offshore. AUSEA complements conventional detection methods such as infrared cameras, ground-based sensors, and satellite monitoring (TotalEnergies, 2022).

(ii) Chevron

In 2023, Chevron contracted GHGSat to monitor methane emissions at 18 oil and gas production facilities worldwide using GHGSat's high-resolution satellite technology. This advanced system can detect and quantify methane emissions from onshore industrial sources. Chevron and GHGSat will continue collaborating on further onshore methane monitoring projects, as well as pilot projects for offshore methane monitoring (GHGSat, 2022).

(iii) QatarEnergy

QatarEnergy has implemented leak detection and repair (LDAR) programmes across its operations. Under this programme, the company measures 100% of the relevant components in its operated assets using toxic vapour analysers (TVAs), following Method 21 from the US Environmental Protection Agency (EPA). The company is also adopting a SMART LDAR approach, where 50% of components are monitored using optical gas imaging cameras, whilst the remaining 50% are measured using TVAs. All components and measurements are recorded in an LDAR software system, allowing calculation and reporting of fugitive emissions (Qatarenergy, 2022).

2.2. Flare and Venting Reduction

(i) PETRONAS

In November 2021, PETRONAS announced its support to the World Bank's Zero Routine Flaring by 2030 Initiative. Under this initiative, PETRONAS pledges to eliminate steady-state flaring in existing oil production sites by 2030, and avoid it altogether in new oil field development. As part of this initiative, PETRONAS will publicly report its flaring data annually, with the first disclosure scheduled for 2023. By 2023, PETRONAS achieved a significant reduction in methane emissions—more than 50% lower than 2020 levels—through its efforts to reduce flaring and off-gas emissions (PETRONAS, 2021, 2023).

(ii) JAPEX

Japan Petroleum Exploration Co., Ltd. (JAPEX) mitigates vent emissions during normal operations by flaring as much excess gas as possible. Low-pressure excess gas, associated with crude oil production, is not flared but instead used as in-house fuel. The company compiles and analyses monthly flare emissions by site, providing feedback to each location to determine abnormalities in flare volumes and further explore reduction measures.

3. Cooperation with Others

3.1. Membership in initiatives and frameworks

Table 4.3 shows major initiatives and frameworks that selected companies worldwide are affiliated with. European companies are typically members of more initiatives and frameworks than their Asian counterparts. Each company participates in at least one initiative or framework, where it measures, reports, and certifies its activities.

Table 4.3. Major Initiatives and Frameworks with which Selected Companies Worldwide are Affiliated

Company	Initiative and Framework
bp	OGCI, OGMP 2.0, etc.
Shell	OGCI, OGMP 2.0, etc.
TotalEnergies	OGCI, OGMP 2.0, etc.
Enagás	OGMP 2.0, GIIGNL, etc.
INPEX	OGMP 2.0, GIIGNL (Associate Members), etc.
JAPEX	GIIGNL (Associate Members), etc.
Tokyo Gas	GIIGNL, etc.
PETRONAS	OGMP 2.0, etc.
Pavilion Energy	GIIGNL, etc.
PTT	OGMP 2.0, GIIGNL, etc.
PERTAMINA	GIIGNL (Associate Members), etc.

bp = British Petroleum, INPEX = International Petroleum Exploration, JAPEX = Japan Petroleum Exploration, PERTAMINA = PT PERTAMINA, PETRONAS = Petroliam Nasional Berhad、PTT = PTT Public Company, Shell = Royal Dutch Shell plc,
Source: Compiled from company data.

3.2. Sharing of expertise

(i) TotalEnergies

TotalEnergies (2024) has been sharing its AUSEA drone detection and measurement technology for methane emissions with several national oil companies, including Petrobras (Brazil), Sonangol (Angola), Nigerian National Petroleum Company, State Oil Company of the Republic of Azerbaijan, and Oil and Natural Gas Corporation (India). This collaboration aims to enhance the detection, measurement, and reduction of methane emissions across these companies' operations.

(ii) JOGMEC–PETRONAS and PERTAMINA

In March 2023, PETRONAS signed a memorandum of collaboration with the Japan Organization for Metals and Energy Security (JOGMEC) to unlock the potential of cleaner energy production and methane abatement opportunities. This collaboration supports decarbonisation goals in both Japan and Malaysia, focusing on the development of technology for methane measurements and the reduction of routine flaring (PETRONAS, 2023).

In December 2023, PERTAMINA and JOGMEC also formalised a cooperation agreement to measure and quantify methane emissions at natural gas production facilities in Indonesia. This partnership focuses on methane emission management projects and carbon intensity calculations for upstream natural gas operations (PERTAMINA, 2023).

(iii) Methane Leadership Program

In June 2023, PETRONAS launched the ASEAN Energy Sector Methane Leadership Program in collaboration with ASEAN energy companies, government agencies, and international organisations. A flagship methane reduction project was announced in partnership with JOGMEC, focusing on methane quantification studies, feasible solutions for achieving zero daily flaring, and potential future cooperation on electrification hubs (PETRONAS, 2023).

The programme's first master class, held in November 2023, drew 65 participants representing Methane Leadership Program partners and ASEAN oil and gas companies from Malaysia, Indonesia, Thailand, and Viet Nam (ASEAN Centre for Energy, 2024).

Figure 4.1. Launch of the Energy Sector Methane Leadership Program

Source: PETRONAS.

4. Technology Development and Operational Improvement

4.1. Measurement innovations

(i) International Methane Emissions Observatory

At the 2022 UN Climate Change Conference in Sharm El-Sheikh, Egypt (COP27), UNEP's International Methane Emissions Observatory (IMEO) launched the Methane Alert and Response System (MARS). MARS is the first global system to connect satellite-detected methane emissions with a transparent notification process, encouraging swift mitigation efforts on the ground (IMEO, 2023). IMEO's third annual report 'An Eye on Methane', released on 1 December 2023, revealed the first public data from MARS. In its inaugural pilot year, focused primarily on the energy sector, IMEO identified around 1,500 methane plumes and sent over 120 MARS notifications across four continents. For instance, a leak at an oil and gas facility was flagged, prompting the company to address the issue and establish a long-term prevention plan.Error! Reference source not found.

(ii) Environmental Defense Fund and Google

In March 2024, the Environmental Defense Fund (EDF) and Google launched the MethaneSAT, a a satellite designed to measure and analyse methane emissions from major oil and gas-producing regions worldwide. EDF and Google will map methane leakage and make this data freely accessible to researchers, regulators, and the public (MethaneSAT).

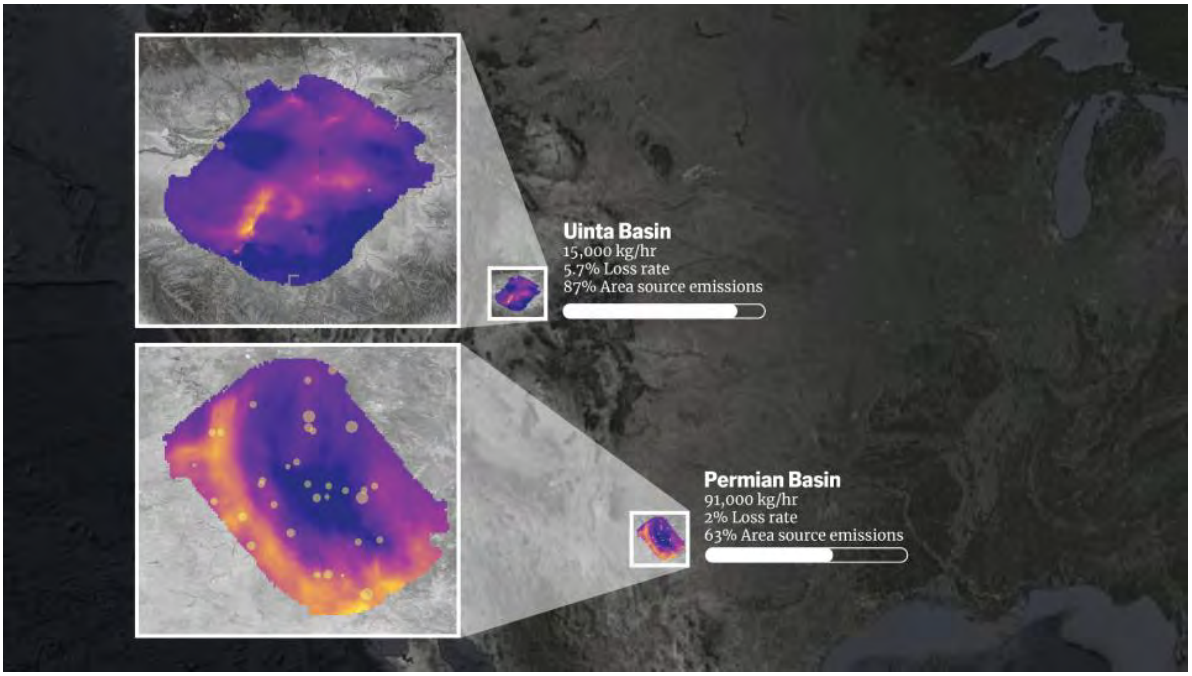
(iii) JGC Holdings Corporation

In March 2023, JGC Holdings Corporation (2023) announced the construction of a facility at its research and development centre in Oarai, Ibaraki in Japan, for evaluating methane emission measurement techniques. The facility aims to support domestic and overseas manufacturers by providing a platform to evaluate their detection capabilities and develop advance methane emission measurement technologies, which are still in their early stages worldwide. With JOGMEC's support, five domestic and foreign companies, including Konica Minolta and All Nipon Airway (ANA), SeekOps (USA), The Sniffers (Europe), and Aeromon (Europe) conducted tests at the facility in February 2023 to evaluate their methane measurement technology.

(iv) Japan Organization for Metals and Energy Security

In November 2022, JOGMEC announced a partnership with ANA to conduct a study on GHG measurement using aircraft and drones. The Japan Aerospace Exploration Agency, which has been working with ANA on verifying the technology, is also involved in this project. The three organisations aim to implement a top-down measurement method, expected to become a verification standard for reported GHG emissions (JOGMEC, 2022).

Figure 4.2. Methane SAT



Note: Basin snapshot.
Source: MethaneSAT.

Figure 4.3. Methane Emission Measurement Technology Evaluation Facility

Source: JGC Holdings.

4.2. Methane emission reduction initiatives

(i) INPEX Corporation

Since FY2021 (April 2021–March 2022), INPEX Corporation has been researching flare reduction measures in cooperation with relevant internal departments. As part of its research and development efforts, INPEX is exploring the introduction of methane cracking technology in Japan to reduce CO_2 emissions from flare by fixing its carbon content (INPEX, 2022).

5. Summary of Corporate Initiatives on Methane Emission Management

Managing methane emissions has increasingly become a key aspect of corporate social responsibility. However, the emission reduction targets and figures announced by companies require standardisation and greater transparency. Currently, the scope of management and the calculation methods used are not consistently unified across companies. In the ASEAN region, some companies have set GHG reduction targets and disclosed their emissions. However, methane emission management remains a secondary focus for most, with only a few companies setting specific targets for methane within their broader GHG emissions management.

Third-party certification and methane emissions certificates are increasingly becoming a competitive differentiator. Increased interest from LNG buyers in transparent emissions data is driving companies to act, which in turn strengthens their market position and encourages further methane emission management.

Whilst progress has been made in developing technologies such as satellites and drones, it is important to promote the introduction of technologies beyond the development stage. In parallel with technological development, sharing the latest know-how, technologies and practices is vital to increase the interest of companies.
Collaboration and the exchange of best practices between companies can accelerate the adoption of methane emission management initiatives.

The low methane emission intensity of Japanese companies demonstrates the effectiveness of their LDAR programmes. This expertise could serve as a valuable model for accelerating methane emission management in ASEAN.

Advanced companies in the ASEAN region, such as PETRONAS, PERTAMINA, and Pavilion Energy, are already leading the way. Initiatives such as the ASEAN Energy Sector Methane Roundtable and the ASEAN Energy Sector Methane Leadership Programme have also been launched to promote collaboration amongst ASEAN companies, with the expectation that these initiatives will gain traction throughout the region.

Chapter 5

Potential for Methane Abatement in ASEAN

This chapter analyses the current state of methane emission management in the ASEAN region, focusing on the potential for abatement, the establishment of best practices, and the evaluation of the International Energy Agency's (IEA) methane emission estimates, using Japan's oil and gas downstream sector as an example.

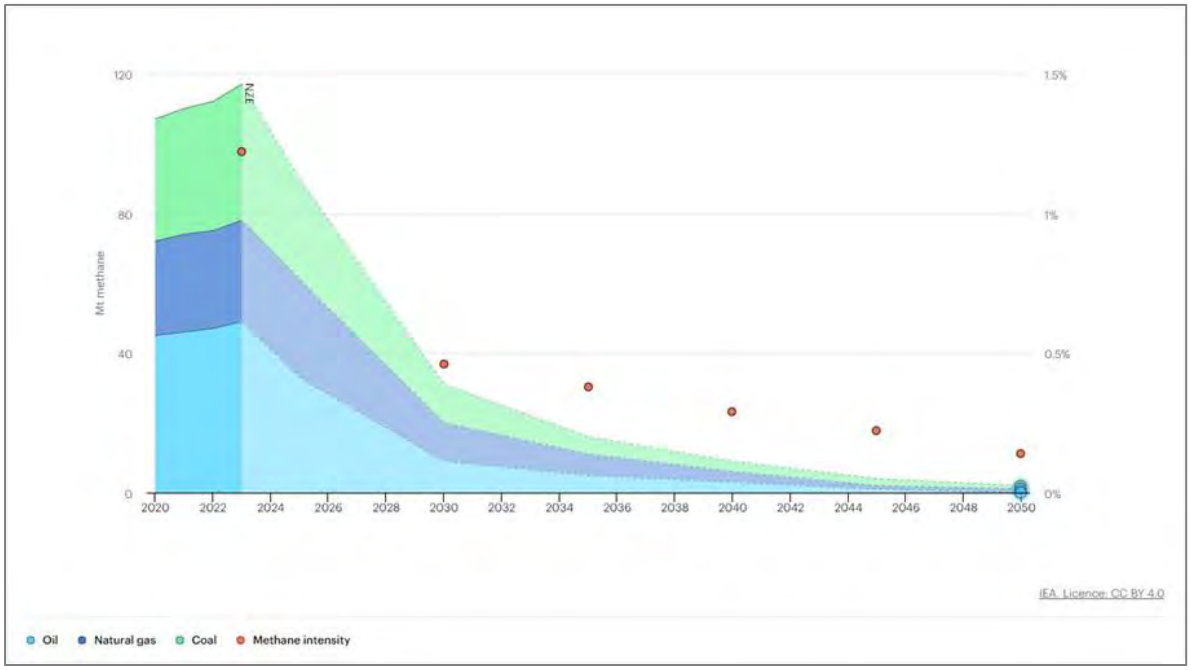
1. Potential for Methane Abatement

Figure 5.1 shows the IEA's net zero emissions scenario for 2050, which is considered ambitious. It projects a reduction in methane emissions of around 75% from current levels by 2030, achieved through a reduction in fossil fuel use and the expansion of clean energy technologies.

As shown, methane emissions from fossil fuel production and use are estimated to have reached nearly 120 million tonnes (Mt) in 2023, with an additional 10 Mt of methane emitted from bioenergy (mainly from traditional biomass use). Since 2019, methane emissions have remained at these levels, following a record high. Meanwhile, fossil fuel supplies have continued to expand, slightly lowering the average methane intensity of global production over this period.

Given the current economic environment, it might be difficult to immediately reduce fossil fuel use as projected by the IEA. However, reducing methane emissions is attracting more attention as an environmentally sound and economically viable measure for ensuring cleaner and more sustainable fossil fuel usage. The following sections provide an objective assessment of the IEA's figures, highlighting the potential for ASEAN oil and gas companies to reduce methane emissions.

Figure 5.1. Methane Emissions and Emissions Intensity of Fossil Fuel Operations in the Net-zero Scenario, 2020–2050



Source: Based on data from the International Energy Agency Methane Tracker 2024.

To assess the potential of methane abatement, unit abatement costs are analysed in relation to methane emissions.

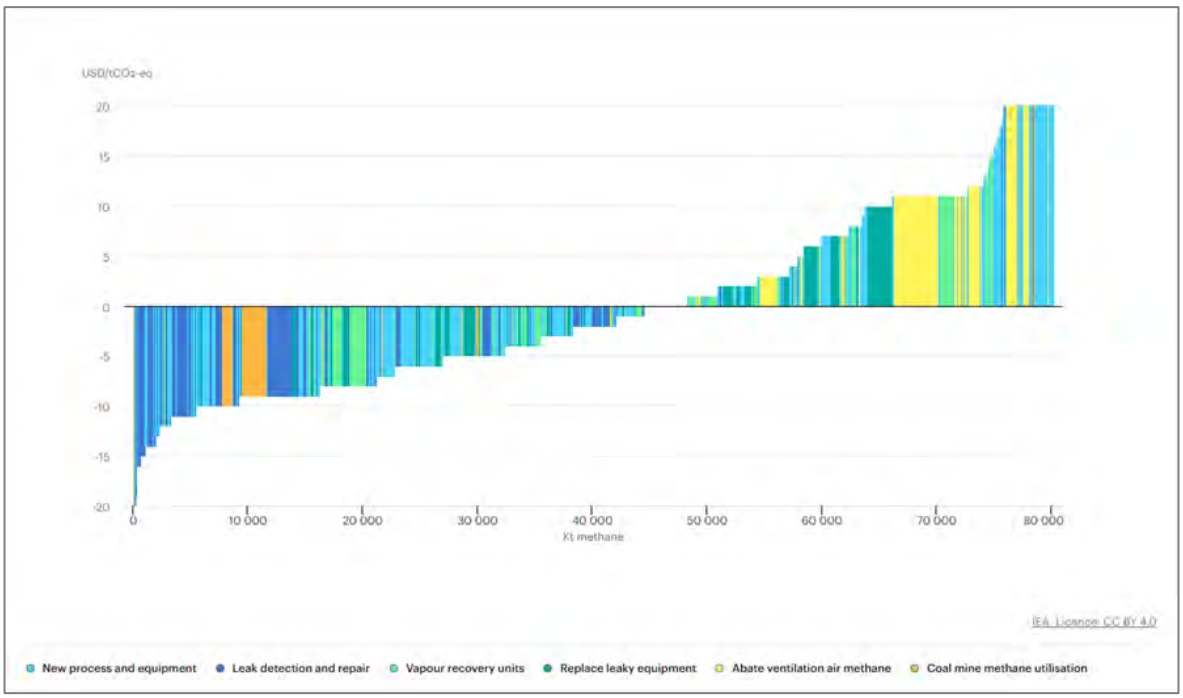
Figure 5.2 shows the cost curve for methane abatement, with methane emissions on the horizontal axis and unit abatement costs on the vertical axis. Bars below zero indicate measures that can be implemented at zero net cost.

The IEA report estimates that almost all methane abatement options can be implemented at prices below US$20 per CO_2-eq, even if the avoided methane has no market value.

IEA emphasises the need to understand why these measures have not been implemented drastically by 2023, despite the fact that around 40% of methane emissions from the fossil fuel sector could be avoided at no cost. Identifying specific projects that could deliver significant reductions remains a challenge. Whilst the net zero-cost measures depend heavily on global gas prices, the range of methane abatement measures, from 40% to 80%, makes it one of the most easily implemented and cost-effective GHG strategies.

As discussed below, the study found that methane abatement in the ASEAN region is even more cost-effective than in other regions.

Figure 5.2. Marginal Abatement Cost Curve for Methane Emissions from Fossil Fuel Operations, 2023



Source: Based on data from the International Energy Agency Methane Tracker 2024.

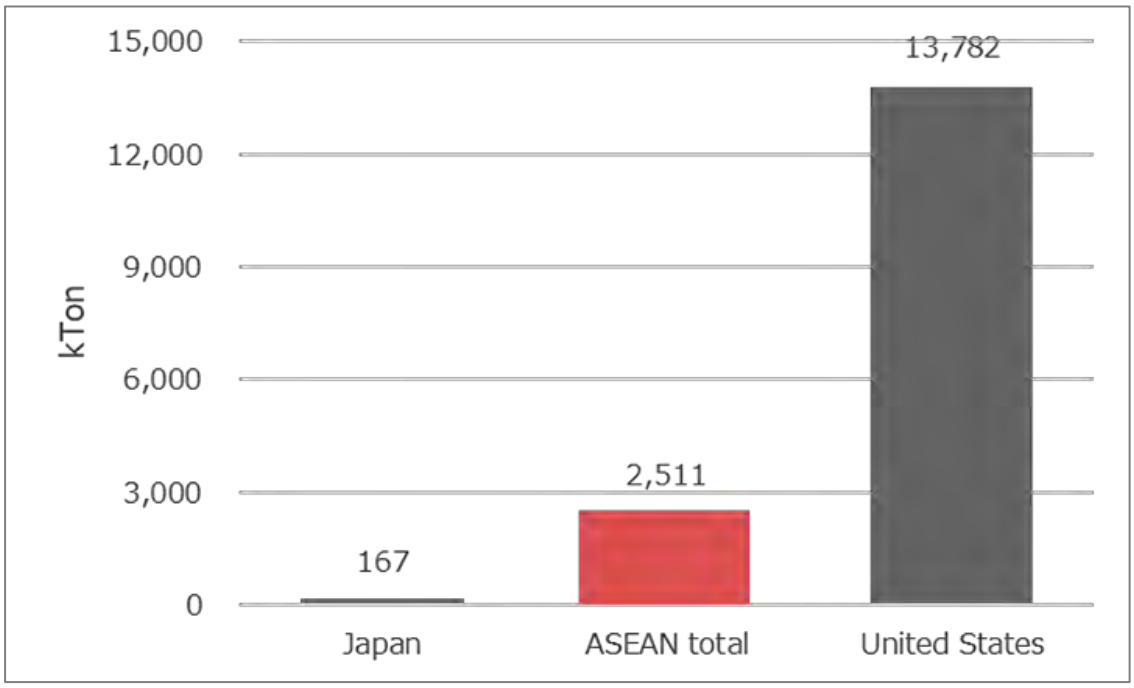
The abatement potential for methane emissions in the ASEAN region is discussed in the following section.

Six ASEAN countries—Brunei Darussalam, Indonesia, Malaysia, the Philippines, Thailand, and Viet Nam—are included in the IEA Methane Tracker 2024. The total methane emissions from these countries are shown in Figure 5.3.

Although the total methane emissions from ASEAN countries are about one-sixth of those from the US, this does not imply that ASEAN emissions are insignificant. In fact, their emissions are comparable to those of large emitters such as Canada, Australia, and Saudi Arabia.

The following data focus solely on the oil and gas industry within the fossil fuel sector, excluding coal and bio energy.

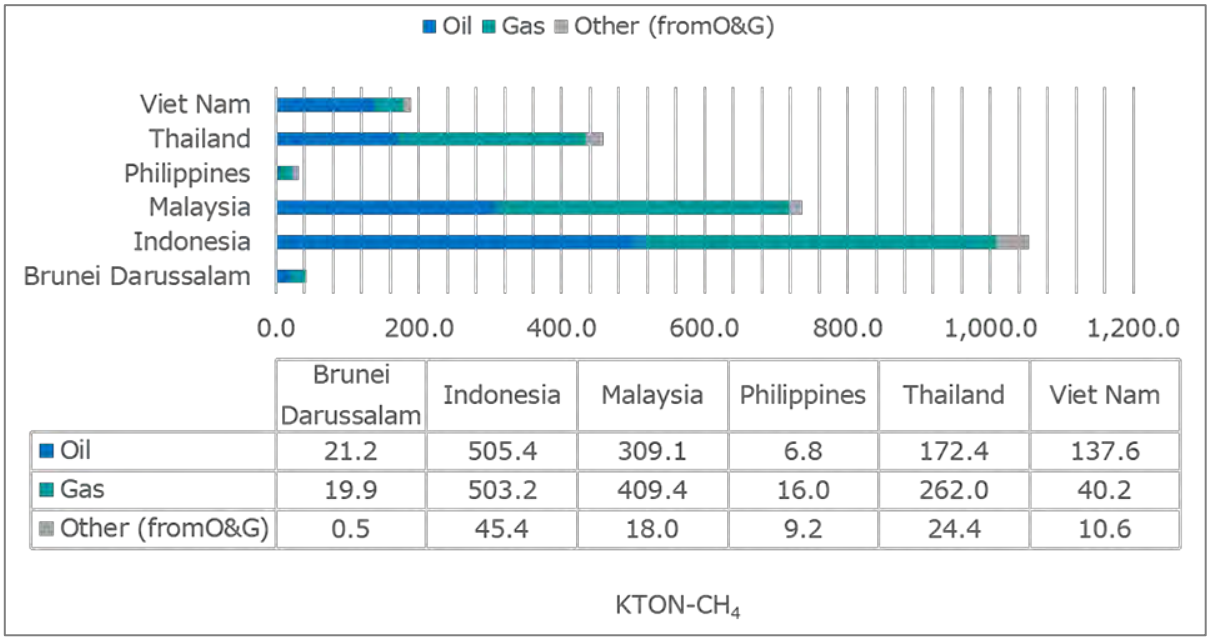
Figure 5.3. Methane Emissions from the ASEAN Oil and Gas Industry



ASEAN = Association of Southeast Asian Nations, KTon = kilotonne.
Source: Based on data from the International Energy Agency Tracker 2024.

The primary source of methane emissions in the ASEAN region comes from upstream oil and gas activities, which explains the high contribution of producing countries to overall emissions. A detailed breakdown of methane emissions by country and by sector within the oil and gas industry is shown in Figure 5.4.

Figure 5.4. Breakdown of Methane Emissions by ASEAN Countries



	Brunei Darussalam	Indonesia	Malaysia	Philippines	Thailand	Viet Nam
Oil	21.2	505.4	309.1	6.8	172.4	137.6
Gas	19.9	503.2	409.4	16.0	262.0	40.2
Other (fromO&G)	0.5	45.4	18.0	9.2	24.4	10.6

ASEAN = Association of Southeast Asian Nations, KTON-CH_4 = kiloton of methane.
Source: Based on data from the International Energy Agency Methane Tracker 2024 (IEA, 2024).

The following three tables show a breakdown of methane emissions from the major oil and gas-producing countries in the ASEAN region, including Indonesia, Malaysia, and Thailand.

Table 5.1. Breakdown of Methane Emissions from Indonesia's Oil and Gas Sector

Indonesia							(Unit: kTon-CH4)
	Offshore Oil	Onshore Oil	Offshore Gas	Onshore Gas	Gas Pipelines and LNG Facilities	Other (NOTE)	Total
Flared	8.6	45.0					53.6
Fugitive	18.5	71.9	68.8	43.2	43.2		245.6
Vented	73.8	287.6	171.8	107.9	68.2		709.3
Subtotal	100.9	404.5	240.6	151.1	111.4	45.4	
Total	1,053.9						

kTon-CH_4 = kilotonne of methane, LNG = liquefied natural gas.
Source: Based on data from the International Energy Agency Methane Tracker 2024 (IEA, 2024).

Table 5.2. Breakdown of Methane Emissions from Malaysia's Oil and Gas Sector

Malaysia							(Unit: kTon-CH4)
	Offshore Oil	Onshore Oil	Offshore Gas	Onshore Gas	Gas Pipelines and LNG Facilities	Other (NOTE)	Total
Flared	34.1	7.1					41.2
Fugitive	51.3	2.3	94.4		30.9		178.8
Vented	205.2	9.2	235.5		48.7		498.6
Total	290.6	18.6	329.9	0.0	79.6	18.0	
Grand Total	736.5						

kTon-CH_4 = kilotonne of methane, LNG = liquefied natural gas.
Source: Based on data from the International Energy Agency Methane Tracker 2024 (IEA, 2024).

Table 5.3. Breakdown of Methane Emissions from Thailand's Oil and Gas Sector

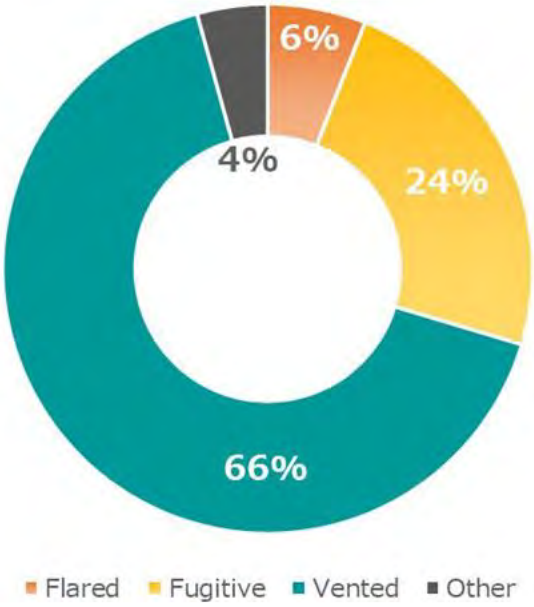
Thailand							(Unit: kTon-CH4)
	Offshore Oil	Onshore Oil	Offshore Gas	Onshore Gas	Gas Pipelines and LNG Facilities	Other (NOTE)	Total
Flared	3.4	9.5					12.9
Fugitive	27.3	4.7	35.8	1.9	50.4		120.1
Vented	109.0	18.6	89.4	4.8	79.6		301.4
Total	139.7	32.7	125.3	6.7	130.0	24.4	
Grand Total	458.8						

kTon-CH4 = kilotonne of methane, LNG = liquefied natural gas.
Source: Based on data from the International Energy Agency Methane Tracker 2024 (IEA, 2024).

A trend analysis of major emission sources from oil and gas activities in the ASEAN region is shown in Figure . Fugitive and vented emissions account for 24% and 66% of total methane emissions, respectively.

Given that fugitive and vented emissions constitute 90% of overall emissions, it is clear that addressing these sources is crucial for effective methane abatement. Methane emissions from flaring are relatively small, as flaring predominantly emits CO_2. The category 'Other' includes methane released due to incomplete combustion (e.g. in utilisation units).

Figure 5.5. Analysis of the Main Source of Methane Emissions



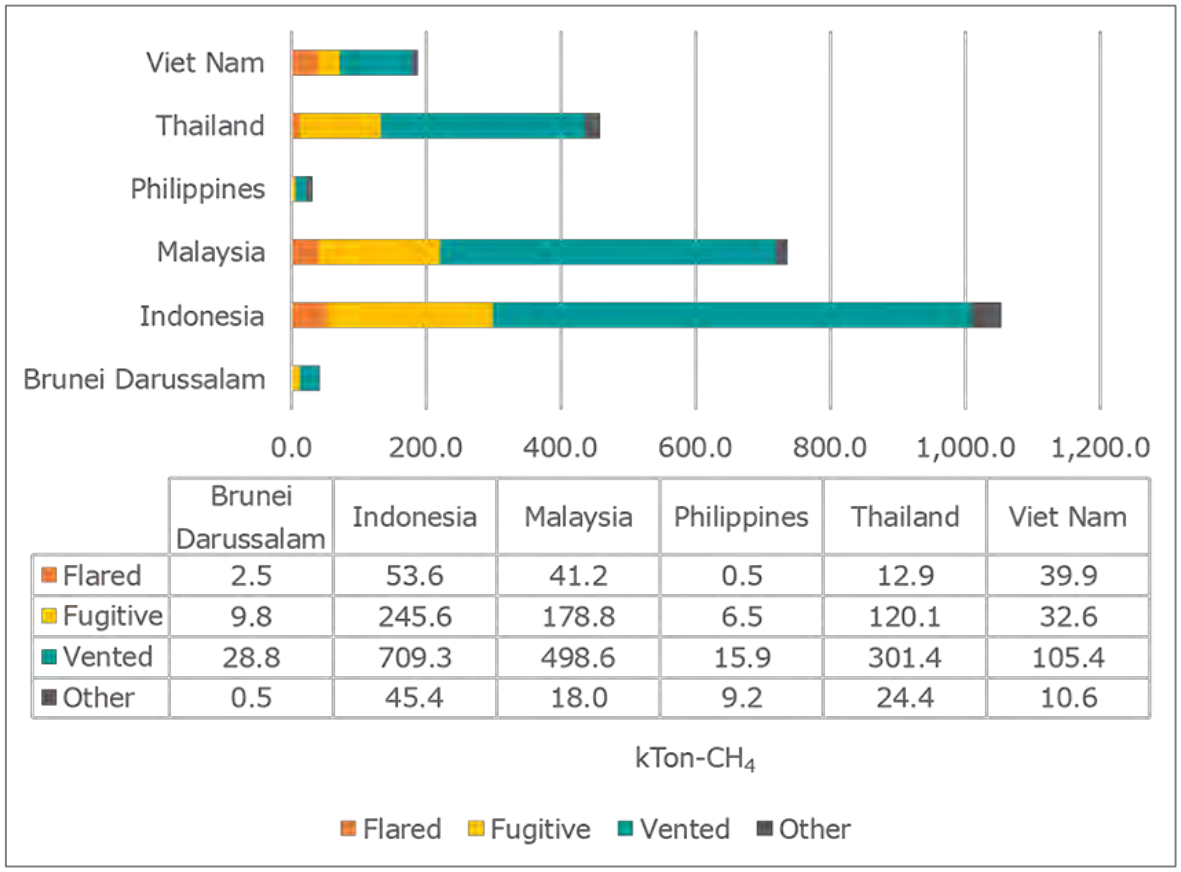
Source: Based on data from the International Energy Agency Methane Tracker 2024 (IEA, 2024).

Figure 5.6 shows a country-specific breakdown of methane emissions, highlighting that most countries follow a similar trend, with venting, fugitive emissions, and flaring being the main contributors, in that order.

The graph also shows that venting is the most effective way to reduce methane emissions, particularly for crude oil production facilities dealing with associated gas. Solutions for managing associated gas include enhanced oil recovery, carbon capture and storage in reservoir, or commercialising it as compressed natural gas.

It is important to note that the IEA estimates are based on production volumes from oil and gas fields, and actual emissions may differ when measured on-site. Therefore, these figures should be considered as reference data, and actual measurements should be used to identify the root causes of methane emissions.

Figure 5.6. Breakdown of Major Methane Emission Sources by ASEAN Countries



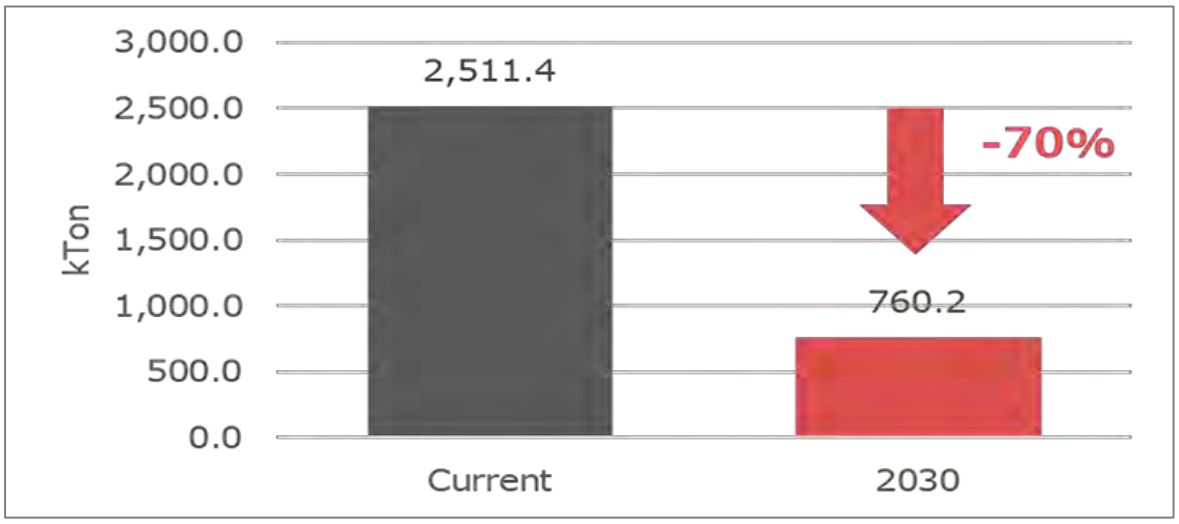
	Brunei Darussalam	Indonesia	Malaysia	Philippines	Thailand	Viet Nam
Flared	2.5	53.6	41.2	0.5	12.9	39.9
Fugitive	9.8	245.6	178.8	6.5	120.1	32.6
Vented	28.8	709.3	498.6	15.9	301.4	105.4
Other	0.5	45.4	18.0	9.2	24.4	10.6

$kTon\text{-}CH_4$ = kilotonne of methane.
Source: Based on data from the International Energy Agency Methane Tracker 2024.

According to the IEA's survey on methane abatement potential, an estimated 70% of methane emissions can be abated using existing technologies (Figure 5.7). The estimated remaining total emitted volume in the ASEAN region by 2030, which stands at 760.2 kT (1,000 tonnes), is comparable to the current methane emissions of an entire country. Achieving this reduction has the potential to bring the region closer to low-carbon fuels by reducing methane intensity.

Figure 5.8 shows the methane abatement potential that can be achieved for each country. There is a large potential for abatement in the key oil and gas-producing countries such as Indonesia, Malaysia, and Thailand.

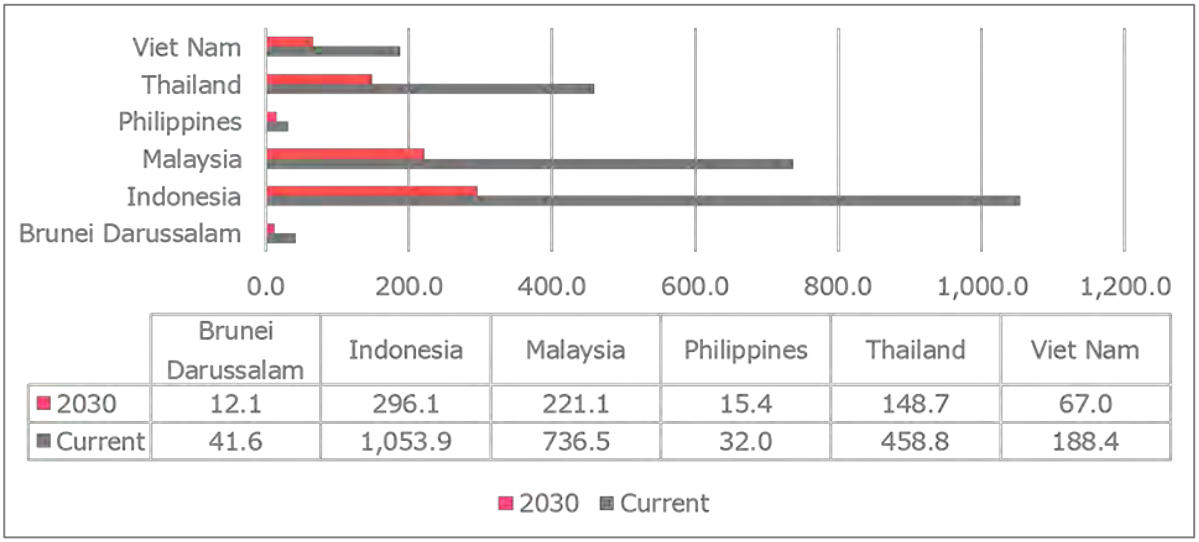
Figure 5.7. Breakdown of Major Sources of Methane Emission by ASEAN Countries



ASEAN = Association of Southeast Asian Nations, kTon = kilotonne.
Source: Based on data from the International Energy Agency Methane Tracker 2024.

Momentum is growing amongst national oil companies in ASEAN to reduce methane emissions. For instance, Malaysia's PETRONAS is already participating in the Oil and Gas Methane Partnership (OGMP) 2.0 initiative, focusing on measurement and reporting, whilst Indonesia's PERTAMINA has also joined. The key to achieving the 2030 target is early quantification of methane emissions and prompt implementation of reduction measures.

Figure 5.8. Breakdown of Methane Abatement Potential by ASEAN Countries



	Brunei Darussalam	Indonesia	Malaysia	Philippines	Thailand	Viet Nam
2030	12.1	296.1	221.1	15.4	148.7	67.0
Current	41.6	1,053.9	736.5	32.0	458.8	188.4

kTon-CH4 = kilotonne of methane.
Source: Based on analysis and data from the Oil and Gas Methane Partnership Methane Tracker 2024.

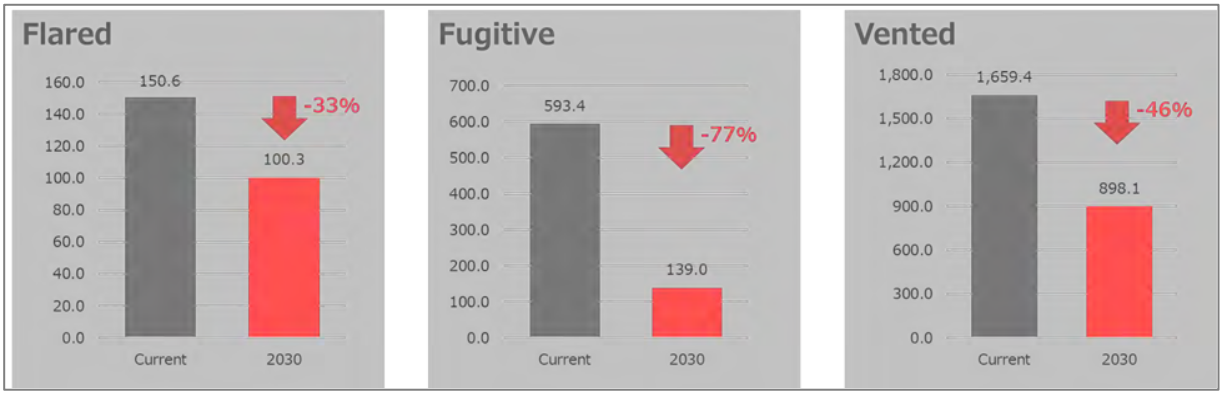
The last part of this chapter examines the abatement potential for the main sources of methane emissions: flared, fugitive, and vented emissions.

Flared emissions. Flared emissions primarily produce CO_2, meaning methane emission abatement from flaring is relatively modest. Reductions can be achieved through the elimination of routine flaring and by improving combustion efficiency with operational improvements and equipment upgrades.

Fugitive emissions. These emissions offer the greatest abatement potential, as they can be tackled directly through regular maintenance, such as flange management. Addressing fugitive emissions is regarded as the most economical and immediate method for methane abatement.

Vented emissions. Vented emissions are an order of magnitude higher than other sources. Reducing vented gas also boosts sales gas production, making it economically advantageous even when retrofitting, such as installing vapour recovery units, is required.

Figure 5.9. Breakdown of Methane Abatement Potential by ASEAN Countries



kTon-CH_4 = kilotonne of methane.
Source: Based on analysis and data from the International Energy Agency Methane Tracker 2024 (IEA 2024).

2. Establishment of Best Practices

To establish best practices in the ASEAN region, it is useful to consider the results of case studies that estimate the abatement potential of each country. Figure 5.10 shows a waterfall chart illustrating the impact of various measures from the current situation towards achieving the 2030 target for each country.

Indonesia. More than half of Indonesia's methane emissions are vented from the oil and gas fields (Table 5.1). Significant reductions can be achieved by installing vapour recovery units (VRUs) and replacing rotating machinery to reduce process venting.

Malaysia. The bulk of methane emissions in Malaysia originates from offshore oil and gas fields (Table 5.2). This highlights the high effectiveness of leak detection and repair (LDAR) programmes, which do not require large investments. Retrofitting offshore oil and gas fields can be more costly compared to onshore fields, further emphasising the value of LDAR.

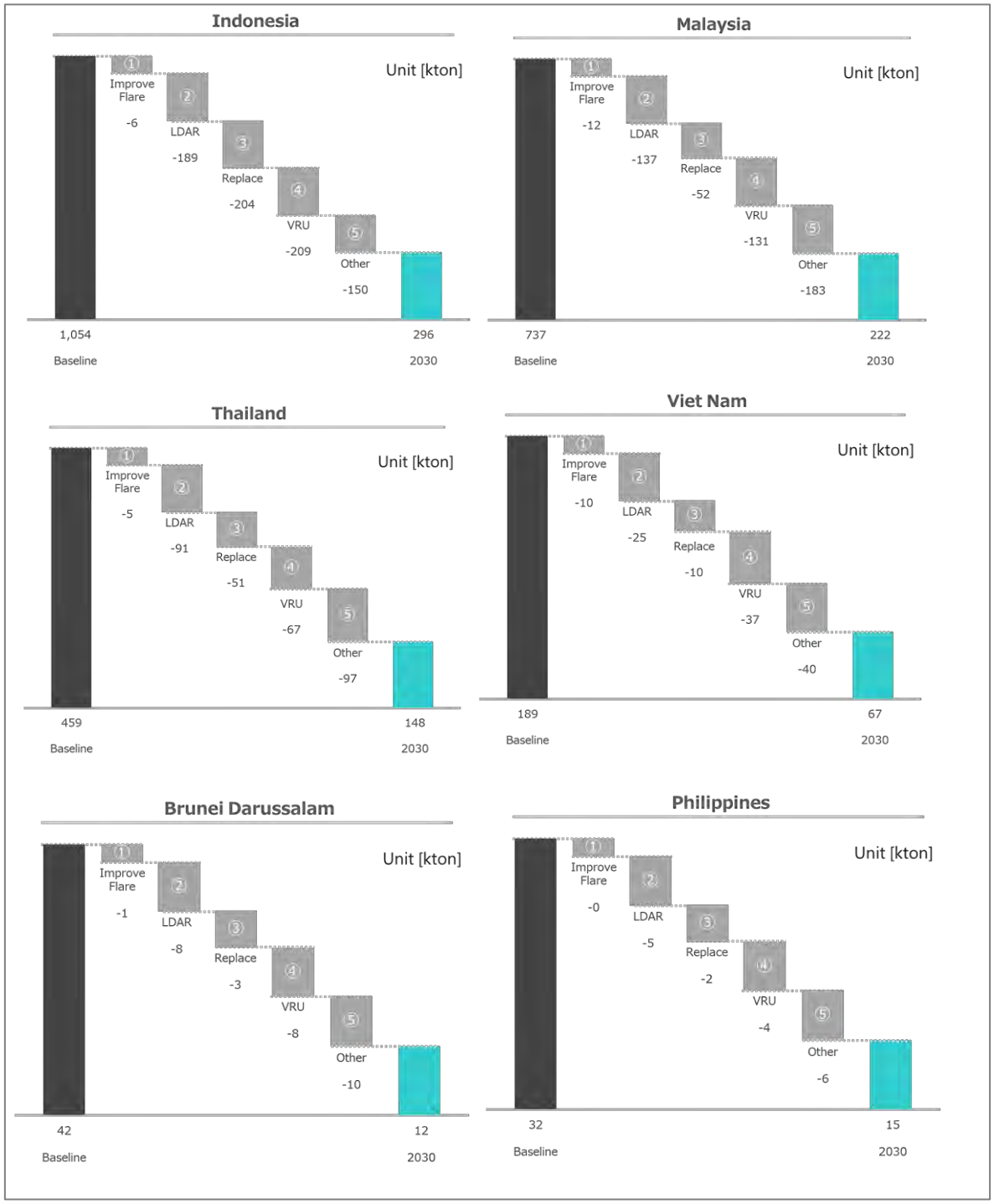
Thailand. Methane emissions from pipelines are higher than those from other sources (Table 5.3). As in Malaysia, the predominance of offshore emissions suggests that LDAR will be particularly effective for abatement efforts.

Viet Nam. With higher oil production compared to gas, and a larger proportion of vented emissions, the use of VRUs will be a more effective abatement measure for this case.

Brunei Darussalam. Most of Brunei's methane emissions come from vented emissions at offshore oil and gas fields, making LDAR and VRU highly effective abatement measure.

Philippines. In countries with smaller-scale gas production, such as the Philippines, LDAR programmes prove to be the most effective for methane abatement.

Figure 5.10. Case Studies of Methane Abatement Potential in Each ASEAN Country



Kton = kilotonne, LDAR = leak detection and repair, VRU = vapour recovery unit.
Source: Based on analysis and data from the International Energy Agency Methane Tracker 2024 (IEA, 2024).

2.1. Technical Abatement Measures

This section provides detailed information on the measures outlined earlier. A wide range of technologies are available for quantifying and reducing methane emissions

from oil and gas fields, though many are not yet fully mature, and there remains some uncertainty in their effectiveness. The choice of technology will depend on factors such as gas prices, the location (onshore/offshore), the source of emissions, and labour costs.

Table 5.4. Pros and Cons of Methane Emissions Reduction Measures

Improve flaring	A dual-strategy method can reduce flaring emissions. The first strategy aims to eliminate routine flaring through operational improvement and retrofitting. The second strategy focuses on enhancing flare combustion efficiency. Though flaring emits both CO_2 and methane, it is generally deemed preferable to direct methane emissions. Installing air-fuel controllers and portable flares can enhance both combustion and capacity. - Pros: Operational improvements increase production ratio. - Cons: Requires advanced engineering skills.
Leak detection and repair	Leak detection and repair (LDAR) programmes are key for mitigating unintentional methane emissions. These involve detecting and repairing leaks using techniques such as handheld sensors and infrared cameras. LDAR can be applied across the oil and gas supply chain. The frequency of monitoring can vary, with more frequent checks ensuring less gas is lost but incurring stable costs. Continuous monitoring systems, using remote or facility-based sensors, can also help mitigate emissions from large, sporadic leaks. LDAR is generally more cost-effective in upstream operations due to the concentrated nature of production facilities. - Pros: Easy to deploy - Cons: Results can typically be obtained on a snapshot basis
Equipment replacement	Many devices in the oil and gas industry, like valves, pneumatic controllers, and pumps, emit natural gas. Retrofitting or replacing these with lower-emitting devices can reduce emissions. For instance, high-bleed pneumatic devices can be replaced with low-bleed or zero-bleed models, whilst gas-driven pumps can be swapped for electric ones. Replacing compressor seals and rods can further reduce gas leaks. - Pros: Offers secondary benefits such as noise reduction - Cons: High retrofit cost and increased electricity consumption

Vapour recovery units	Vapour recovery units are compressors that capture emissions from oil and gas equipment, such as those released from oil storage tanks. Capturing blowdown gas during equipment depressurisation can also reduce emissions. - Pros: Increases production ratio. - Cons: High retrofit costs.
Other Measures	The International Energy Agency is exploring innovative techniques beyond traditional methods. These include methane-reducing catalysts, microturbines for remote gas use, pre-maintenance pipeline pump-downs, and green completions.

Source: Based on analysis and data from the International Energy Agency Methane Tracker 2024.

2.2. Policy-based Abatement Measures

Policies aimed at reducing methane emissions in the oil and gas industry also contribute to abatement. Key policies include LDAR programmes, technology standards, and zero non-emergency flaring and venting regulations. LDAR programmes mandate regular inspections and timely repairs, whilst technology standards require the use of lower-emitting equipment. Zero routine flaring and venting policies aim to minimise these practices altogether.

Additional policy-driven measures, supported by robust monitoring, help further encourage methane abatement. These strategies have been modelled within the IEA methane emission framework for effectiveness.

Figure 5.11 and Figure 5.12 show the signatories to major international initiatives aiming for better methane emission management at both company and government levels. Malaysia leads the ASEAN region in these efforts.

One concern is that most signatories are international oil companies and super emitters, with relatively little participation from ASEAN companies. Whilst some companies may prefer to maintain a low profile, increasing transparency by proactively disclosing methane emissions reduction efforts could enhance their reputation and competitiveness.

The Oil and Gas Decarbonization Charter is part of the Global Decarbonization Accelerator, announced at COP28 and signed by over 50 companies, representing over 40% of global oil production. Over 60% of the signatories are national oil companies.

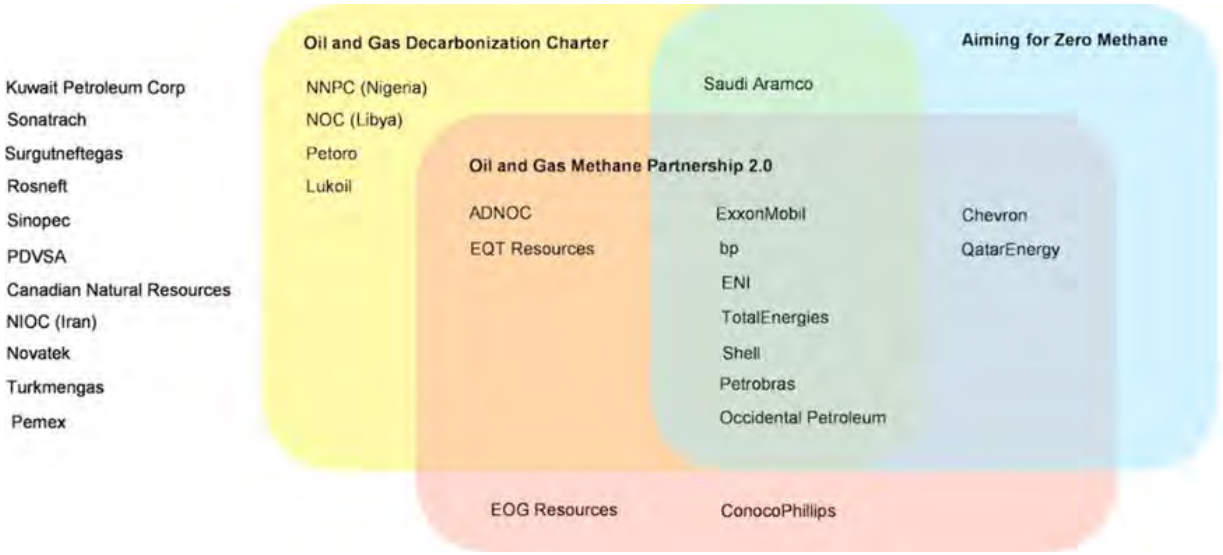
Amongst the signatories from the ASEAN region (though not listed in the figures) are as follows:

- ✓ PTTEP (Thailand)
- ✓ PETRONAS (Malaysia)
- ✓ PERTAMINA (Indonesia)

These companies have committed to reducing methane emissions, ending routine flaring by 2030, and achieving net-zero operations by 2050. These initiatives are being carried out as part of the broader Oil and Gas Decarbonization Charter framework.

For the Global Methane Pledge, several ASEAN countries, including Cambodia, Indonesia, the Philippines, Singapore, and Viet Nam, have joined.

Figure 5.11. Signatory Companies to Selected International Methane Initiatives



NIOC = National Iranian Oil Company, NOC = National Oil Corporation, PDVSA = Petróleos de Venezuela, S.A., PETRONAS = Petroliam Nasional Berhad, PTTEP = PTT Exploration and Production Public Co., Ltd.
Source: Based on data from the International Energy Agency (IEA) Methane Tracker 2024, March 2024. Whilst PTTEP, PETRONAS, and PERTAMINA are not listed in the figure published by the IEA (2024), they are signatories to the Oil and Gas Methane Partnership 2.0 and the Oil and the Gas Decarbonization Charter.

Figure 5.12. Countries and Regions Participating in the Global Methane Pledge, Initiatives, and Action Plans

Source: Based on data from the International Energy Agency (IEA) Methane Tracker 2024. Cambodia, Indonesia, the Philippines, Singapore, and Viet Nam from the ASEAN region, along with Japan, Korea, and Timor-Leste in East Asia, have joined the Global Methane Pledge, although they are not listed in the figure published by IEA (2024).

3. Establishing Best Practices

The assessment of total methane emissions, methane abatement potential, and best practices in the ASEAN region's oil and gas sector indicates significant opportunities for methane reduction.

Figure 5.13. Key Takeaways from Best Practice Analysis

Methane abatement potential in ASEAN	✓ **Fugitive emissions** and **Vent emissions** account for 90% of the total emission volume ✓ 70% emission can be reduced by **existing technical abatement measures**
Methane abatement best practice	1. Quantify methane emission flow rate by on-site measurement. 2. (Short-term) Make the most economical effect first with LDAR." 3. (Mid-term) Consider zero flaring system. 4. (Mid-teem) Consider VRU installation and equipment replacement.

ASEAN = Association of Southeast Asian Nations, LDAR = leak detection and repair, VRU = vapour recovery unit.
Source: Author.

Methane abatement potential. The potential for methane abatement in the ASEAN region is considerable, especially in the oil and gas sector. With the adoption of existing technologies and practices as measures, such as LDAR, equipment upgrades (e.g. VRUs), and process optimisation, emissions could be reduced by up to 70%.

Best practice development. Establishing best practices amongst ASEAN companies is important for achieving sustainable methane emission reductions. The key to achieving the 2030 methane abatement target is accurately quantifying methane emissions and promptly implementing reduction measures. Moreover, emissions data should be used for reference, but actual on-site measurements are essential to identify specific sources of methane emissions.

The first step towards methane abatement in the oil and gas industry is accurate on-site emissions quantification. This will validate the effectiveness of measures and provide valuable insights for local policy development and corporate strategy.

Collaboration between ASEAN companies will facilitate innovation in methane abatement efforts and encourage sharing of quantification and abatement technologies.

In conclusion, ASEAN companies are well-positioned to play a key role in the global transition to a low-carbon economy by exploiting methane abatement potential and adopting best practices. Reducing methane emissions not only aligns with environmental goals but also offers economic benefits through improved productivity, efficiency, and regulatory compliance.

This chapter's analysis of IEA data shows that methane abatement is a highly beneficial strategy for the oil and gas industry in the ASEAN region.

As the demand for GHG-abated fossil fuels grow, methane emissions abatement is a recommended and immediate step towards a sustainable future.

Chapter 6
Recommendations

1. Key Recommendation 1: ASEAN Stakeholders Should Respect Fundamental Methane Emission Management Practices

A phased, step-by-step deployment of effective measures is recommended.

As highlighted in Chapter 5, fugitive and vented emissions account for 90% of methane emissions in the oil and gas sector, making them a priority for action. Immediate attention should focus on identifying fugitive leaks through leak detection and repair (LDAR), as no specific technical requirements are needed to initiate these activities. LDAR can deliver short-term results, whilst the installation of vapour recovery units and the achievement of zero flaring should be considered medium-term goals.

The first step in methane abatement is to quantify site-specific methane emissions.

The first best practice for reducing methane emissions in the oil and gas industry is accurate quantification in the field. According to the International Methane Emissions Observatory (IMEO), large discrepancies are being observed between field measurements and calculations based on general emission factors. Addressing this will be a key focus for IMEO in 2024 (IMEO, 2023). Operators must therefore accurately identify their methane emissions to ensure the effectiveness of their mitigation efforts, as demonstrated by previous studies.

2. Key Recommendation 2: ASEAN Should Play a Proactive Role in Global Methane Emission Management Whilst Ensuring Energy Security

ASEAN is the fourth-largest emitter of methane globally, after China, the US, and India, according to the IEA Methane Tracker. Coordinated efforts across the ASEAN region, rather than isolated national efforts, could significantly reduce global methane emissions and influence the direction of global methane emission management initiatives.

Malaysia can lead in methane emission management efforts.

As the region's largest natural gas producer and consumer, Malaysia's relatively low methane emissions position it as a potential leader in emissions management. Given Malaysia's influence in the ASEAN natural gas sector, its leadership in methane emission management could quickly spread across the region.

ASEAN should leverage advanced companies and inter-corporate collaboration.

Globally, companies are adopting methane emission management through alliances and industry-led guidelines. In the ASEAN region, companies like PETRONAS and Pavilion Energy have already begun collaborating through initiatives like the Methane Leadership Program. These efforts could serve as a model for other ASEAN companies, fostering regional cooperation in methane emission management.

3. Key Recommendation 3: Standardisation and Harmonisation of Methane Emission Measurement Guidelines are Essential

The variety of guidelines for measuring and reporting methane emissions creates challenges for comparing emissions across frameworks and for calculating total emissions across supply chains. Standardising and coordinating these guidelines is a priority. Whilst companies disclose their reduction targets and emissions data as part of their corporate social responsibility, methods of calculation and target-setting vary. Ensuring standardisation and transparency will enhance credibility. There have been a few attempts to address the issue, mainly from Europe and the US. Some ASEAN stakeholders who can participate in this process should work to implement the content in the ASEAN region.

The significant discrepancies between IEA Methane Tracker data and national government reports highlight the need to address uncertainties in emission factors and to identify previously unaccounted-for methane sources. These differences suggest a reliance on underestimated or imprecise emission factors. In the ASEAN region, expanding direct measurement efforts and updating emission factors will improve the accuracy of methane emissions data.

4. Key Recommendation 4: ASEAN Should Leverage the Expertise of Japanese Companies to Accelerate Methane Emission Management

Japanese companies have maintained low methane emission intensities due to long-term efforts in leak detection. ASEAN can benefit from this expertise to accelerate methane emission control. Strengthening cooperation between ASEAN and Japanese companies, including the implementation of demonstration projects using the latest technologies, could lead to significant advancements in the region.

5. Recommendation 5: Opt for Low Methane Emission Gas

During the energy transition, the continued use of natural gas must focus on cleaner practices, particularly the elimination of methane emissions gas along the supply chain. It is not only essential to reduce methane emissions domestically but also across the entire supply chain by selecting natural gas with lower methane emissions.

As public interest in methane emission reduction grows, companies that manage methane emissions responsibly will stand out. Products with certified, well-managed, low methane emissions can offer a competitive edge, enhancing the market position.

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