ERIA Research Project Report FY2023 No. 28

# Effective Management of Methane Emissions in ASEAN

**Edited by**

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**Effective Management of Methane Emissions in ASEAN**

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# Preface

While liquefied natural gas (LNG) has numerous advantages and can enhance economic competitiveness, environment, and energy security (3Es) of Asia, partly because of its relative cleanliness and lower carbon dioxide emission profiles compared to other fossil energy sources, new issues have been gaining momentum – emissions of methane, the main component of natural gas itself.

The general public does not understand that most methane emissions come from outside the LNG and gas industry. It may be difficult to distinguish methane as a clean energy source and methane emissions as one of the culprits of global warming.

The LNG and gas industry now has to prove that it contributes to solving the methane emission problem rather than a cause of the problem. Taking good care of public relations on this front is important – making the industry look more serious.

Secondly, gas systems are unequal and different from country to country. Some gas systems may emit more greenhouse gases than others. In that sense, the best practices must be shared to save the industry. When applied to different regions, the best practices may have to be adjusted to local conditions.

Thirdly, it is increasingly important to think about Scope 3. Producers should closely examine how their gas production is eventually consumed. Consumers should closely look into how their gas sources are produced without causing harm (emissions during the process).

Companies and authorities should take a closer look at the corporate and site levels, as well as cargo-specific emission profiles, to ensure clean gas should be even cleaner.

The authors hope this study will provide new insights for the sound development of the LNG market in the Asian region with better methane emissions management.

**Hiroshi Hashimoto**

Leader of the Working Group

# Acknowledgements

This study was undertaken based on close discussions with specialists and industry officials who are focused on methane and GHG emission management issues in ASEAN, Japan, and other regions on the planet. The authors particularly would like to thank all the participants in the online workshop on 28 June 2023, as well as the respondents to the written survey on their thoughts on this issue after the event.

The presentations at the workshop – from the region's industry players, government authorities, and stakeholders from other areas that are also active in Southeast Asia and the United States – and ensuing discussions were very useful and inspiring to develop future strategies and policy measures to support methane emission management activities.

The authors would also like to express sincere appreciation to Paul Everingham, Chief Executive Officer, Asia Natural Gas and Energy Association (ANGEA), and his team; and Glen Sweetnam, Senior Vice President of the Asia Pacific Energy Research Centre (APERC) and researchers in his team, for their kind and generous support for this study, without which this report would not be possible. All errors and mistakes are the authors' responsibility.

**Hiroshi Hashimoto**

Leader of the Study Group

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# List of Abbreviations and Acronyms

| | |
|---|---|
| ANGEA | Asia Natural Gas and Energy Association |
| APERC | Asia Pacific Energy Research Centre |
| CAA | Clean Air Act, United States |
| CH4 | methane |
| CO2 | carbon dioxide |
| EC | European Commission |
| 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 |
| GWP | Global Warming Potential |
| IEA | International Energy Agency |
| IMEO | International Methane Emissions Observatory |
| INPEX | INPEX Corporation, Japan |
| IPCC | Intergovernmental Panel on Climate Change |
| IRA | Inflation Reduction Act, United States |
| JAPEX | Japan Petroleum Exploration Co., Ltd. |
| JOGMEC | Japan Organization for Metals and Energy Security |
| LDAR | leak detection and repair |
| MARS | Methane Alert and Response System |
| METI | Ministry of Economy, Trade and Industry of Japan |
| MoU | memorandum of understanding |
| MRV | measurement, reporting, and verification |
| N2O | nitrous oxide |
| NDC | Nationally Determined Contribution |
| NGSI | Natural Gas Sustainability Initiative |
| OGCI | Oil and Gas Climate Initiative |
| OGMP | Oil and Gas Methane Partnership |

| | |
|---|---|
| OGMP2.0 | Oil and Gas Methane Partnership 2.0 |
| PTT | PTT Public Company Limited, Thailand |
| SHK | Japanese acronym for Calculation, Reporting, and Publication |
| UN | United Nations |
| UNEP | United Nations Environment Programme |
| UNFCCC | United Nations Framework Convention on Climate Change |
| US | United States |
| VRU | vapour recovery unit |

# Introduction

As demonstrated by international initiatives in recent years – including the Global Methane Pledge (GMP),[1] the International Methane Emissions Observatory (IMEO),[2] and the Oil and Gas Methane Partnership 2.0 (OGMP2.0)[3] – the methane emission issue has been attracting more attention, with the natural gas value chain being targeted as a 'low-hanging fruit' for emission reductions. Especially after the global gas crisis in 2022, the sustainability of natural gas supply has gained more significance along with supply security.

One reason for this attention includes the suspected higher global warming potential (GWP) of methane in shorter time scales. The period usually used for GWPs is 100 years. Methane (CH4) is estimated to have a GWP of 29.8 over 100 years. CH4 emitted today lasts about a decade on average, much less than carbon dioxide (CO2). Because of methane's shorter stay in the atmosphere, the 20-year GWP is sometimes used as an alternative to the 100-year GWP in recent years. CH4's 20-year GWP is said to be much higher at 82.5.[4]

The momentum has gained more speed in 2023 as the issue was dealt with at the annual LNG Producer-Consumer Conference in Tokyo and at the Energy Asia event in Kuala Lumpur earlier in the summer. Some international initiatives have also been underway to develop standards for methane (and GHG) emission measurement, reporting and verification (MRV), leak detection and repair (LDAR), and other abatement measures.

The study aims to pursue a resilient strategy to address the methane emission issue alongside the natural gas value chain in the most prominent region of the natural gas business, ASEAN. Although the methane emission issues have attracted more attention in the Western world (Western Europe and North America), the problems have not yet obtained industry-wide recognition in the ASEAN region as the regional government authorities have not acted on the policy and regulatory side.

The purposes of this study include

- ✓ promoting understanding of the issue by regional stakeholders;
- ✓ studying how emissions have been monitored, managed, and reduced throughout the natural gas value chain in the region; and
- ✓ developing recommendations to relevant stakeholders in the region – government authorities, regional industry organisations, and players in the industry – on how to deal with the issues through enhanced regional cooperation.

Ultimately, enhanced efforts and initiatives to reduce and manage methane emissions should enable natural gas and LNG to survive the energy transition and improve 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).

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[1] Launched in November 2021, https://www.globalmethanepledge.org/.

[2] Launched in October 2021, https://www.unep.org/explore-topics/energy/what-we-do/methane/about-imeo.

[3] Launched in November 2020, https://ogmpartnership.com/.

[4] IPCC Sixth Assessment Report, Working Group 1: The Physical Science Basis, Chapter 7: The Earth's Energy Budget, Climate Feedbacks and Climate Sensitivity, Table 7.15, https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Chapter07.pdf/

During the study, the study team recognised that the United States (US), Canada, and Europe intended to strengthen their efforts around COP27 in November 2022. This was identified as a move that would have even more substantial international impacts.

- ✓ Under the Inflation Reduction Act (IRA), the US introduced methane charges to facilities that emit more than 25,000 tonnes of CO2 equivalent per year – from $900/t in 2024 to $1,500/t in 2026. The US Environmental Protection Agency (EPA) introduced financial and technical support to curb methane emissions.
- ✓ Canada has tightened its periodic measurement and reporting rules to reduce methane emissions from the oil and gas sector by 40%–45% below 2012 levels by 2025.[5]
- ✓ The European Union (EU) initially focused on reducing methane emissions within the EU. However, its ultimate goal is to limit emissions from fossil fuel imports as data becomes available in the coming years.[6]

The industry has led notable developments to enhance recognition of the methane issue in the ASEAN region, including the ASEAN Methane Roundtable series[7] led by Malaysia's Petronas, Thailand's PTT, and Indonesia's Pertamina since 2021. Petronas became a member of OGMP2.0 in November 2022.[8] The Japan Organization for Metals and Energy Security (JOGMEC) and JGC Holdings of Japan are willing to cooperate in the region – including site-level emission measurement programmes.

During this study, one online workshop was held to enhance understanding of the issue at both global and regional levels. The study team would like to continue efforts to understand efforts and initiatives by companies, industry associations, and government authorities in the region to help develop better strategy to tackle the issues.

[5] 'In 2016, Canada and the US issued a Joint Statement on Climate, Energy, and Arctic Leadership, where both countries committed to reduce methane emissions by 40% to 45% below 2012 levels by 2025 from the oil and gas sector. . .' (Reducing Methane Emissions from Canada's Oil and Gas Sector: Discussion Paper, March 2022), https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/consultation-reducing-methane-emissions-oil-gas-sector.html.

[6] '. . . the Commission adopts a two-step approach to addressing methane emissions from imports of fossil energy to the EU. First, the Commission proposes a number of transparency measures to encourage significant methane emissions abatement globally and in particular in the countries supplying fossil energy to the EU. In the second step, the Commission proposes to evaluate the implementation of those measures to consider strengthening the requirements on importers to abate methane emissions'. (Questions and Answers on reducing methane emissions in the energy sector, 15 December 2021) https://ec.europa.eu/commission/presscorner/detail/en/qanda_21_6684.

[7] 'PETRONAS, Key ASEAN Energy Players to Intensify Collaboration in Addressing Methane Emissions,' 27 October 2021, https://www.petronas.com/media/media-releases/petronas-key-asean-energy-players-intensify-collaboration-addressing-methane.

[8] 'PETRONAS Strengthens Methane Emissions Management, Boosts Decarbonisation Efforts via New Alliances at COP27', 11 November 2022, https://www.petronas.com/media/media-releases/petronas-strengthens-methane-emissions-management-boosts-decarbonisation.

**Table 1. Notable Worldwide Developments on Methane Emission Management Issues**

| | Europe | Asia | Americas | Global |
|---|---|---|---|---|
| 2020 | EU Methane Strategy / OGMP2.0 | | | |
| 2021 | IMEO<br>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, EU, Japan, Singapore, Canada, Norway, and the United Kingdom joint declaration on reducing emissions from traded fossil fuels[a] |
| 2023 | European Parliament position on methane legislation binding 2030 methane reduction targets and 2026 gas importer methane intensity standards[b] | ASEAN Energy Sector Methane Leadership Program[c] | EU-USA Energy Council recognises needs to collaborate common approach on MRV and reduction efforts[d] | G7 Climate, Energy and Environment Ministers agree on methane emission reduction efforts and needs of MMRV standard[e] |

[a] 'Joint Declaration from Energy Importers and Exporters on Reducing Greenhouse Gas Emissions from Fossil Fuels', 11 November 2022, https://ec.europa.eu/commission/presscorner/detail/en/statement_22_6827; https://www.gov.uk/government/publications/reducing-greenhouse-gas-emissions-from-fossil-fuels-joint-declaration-from-energy-importers-and-exporters.

[b] 'Fit for 55: MEPs Boost Methane Emission Reductions from the Energy Sector', 9 May 2023, https://www.europarl.europa.eu/news/en/press-room/20230505IPR84920/fit-for-55-meps-boost-methane-emission-reductions-from-the-energy-sector.

[c] 'PETRONAS Collaborates with Partners to Accelerate Methane Emissions Reduction', 27 June 2023, https://www.petronas.com/media/media-releases/petronas-collaborates-partners-accelerate-methane-emissions-reduction.

[d] 'The Council intends to continue advancing the reduction of global methane emissions in line with the Global Methane Pledge and the Joint Declaration from Energy Importers and Exporters on Reducing Greenhouse Gas Emissions from Fossil Fuels. The Council intends to promote domestic and international measures for reinforced monitoring, reporting, and verification, as well as transparency, for methane emissions data in the fossil energy sector, such as through the Oil and Gas Methane Partnership 2.0 (OGMP 2.0) standard and the development of a common tool for life cycle analysis of methane emissions for hydrocarbon suppliers and purchasers. Building upon the Joint Declaration, the Council intends to work with Joint Declaration members and other countries to develop an internationally aligned approach for transparent measurement, monitoring, reporting, and verification of methane and carbon dioxide emissions across the fossil energy value chain to improve the accuracy, availability, and transparency of emissions data at cargo, portfolio, operator, jurisdiction and basin-level.' (Joint Statement following the 10th EU-US Energy Council) 4 April 2023, https://ec.europa.eu/commission/presscorner/detail/en/STATEMENT_23_2121.

[e] '61 Methane … an internationally aligned approach for measurement, monitoring, reporting, and verification of methane and other GHG emissions to create an international market that minimises GHG emissions across oil, gas, and coal value chains, including by minimising flaring and venting, and adopting best available leak detection and repair solutions and standards. (G7 Climate, Energy and Environment Ministers' Communiqué) 17 April 2023, https://www.meti.go.jp/press/2023/04/20230417004/20230417004-1.pdf.

Source: Compiled from announcements of governments and organisations.

The study team also recognised the following 'inconvenient truths of the methane emission issues for the LNG and gas industry', which should be overcome for the industry to survive.

1) The general public does not understand that most methane emissions are outside the LNG and gas industry.
    a) However, the LNG and gas industry now has to prove that it contributes to solving the methane emission problem rather than a cause of the problem.
    b) Taking good care of public relations is important – making the industry look more serious.
2) Gas systems are made unequal. Some gas systems emit more than others.
    a) The best practices now have to be shared to save the industry.
    b) The best practices may have to be adjusted to local conditions when applied to different regions.
3) It is increasingly important to think about Scope 3.
    a) Take a close look at how your gas production is eventually consumed.
    b) Look closely at how your gas sources are produced without causing harm (emissions during the process).
    c) Take a close look at the corporate and site levels and cargo-specific emission profiles.

Based on the above background, methane emissions management from the energy sector, particularly from the natural gas and LNG supply chain, is the focus of this study. The scope of the study is categorised into methane emissions status, policies, initiatives and frameworks, and related technologies. By comparing and analysing the study results of each viewpoint in various regions (global and ASEAN), the study provides recommendations for effective methane emission management matching the characteristics of the ASEAN region.

# Chapter 1

# Global Methane Emissions

## 1. Methane Emissions Update

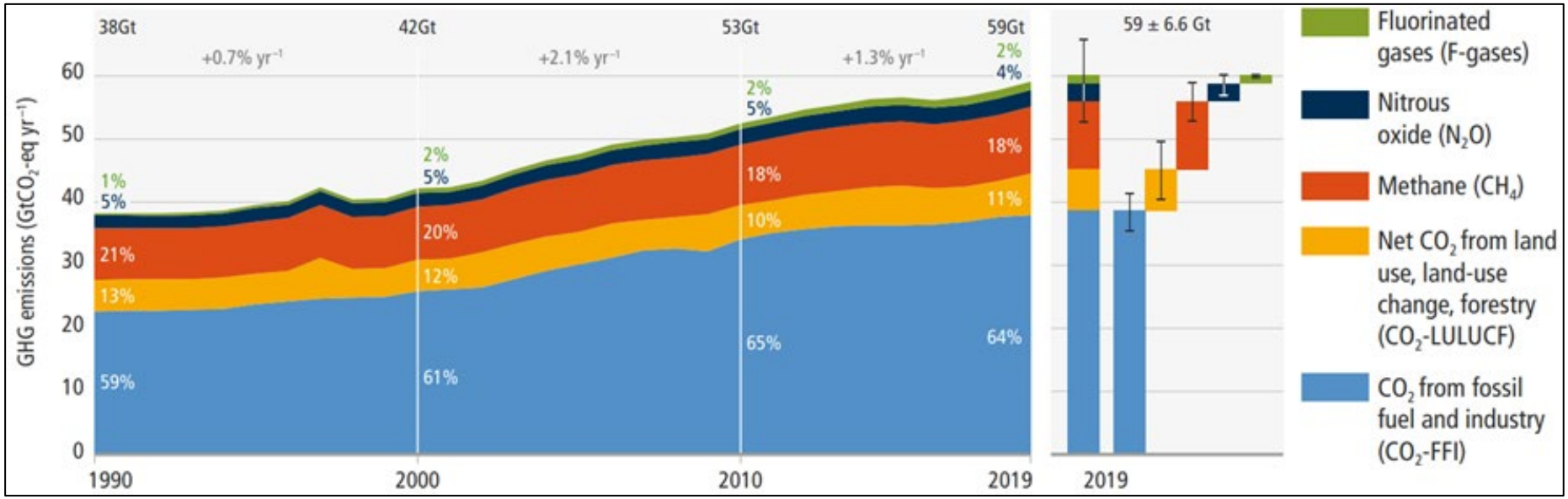
This chapter analyses the reported methane emissions calculated by national governments and estimated data compiled by different research institutions to summarise the global and ASEAN methane emissions situation.

### 1.1. Intergovernmental Panel on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science related to climate change.[9] It was established in 1988 to provide policymakers with regular scientific assessments on the current state of knowledge about climate change by the World Meteorological Organization and the United Nations Environment Programme (UNEP),[10] and is currently participated by 195 countries and regions. The IPCC evaluates the latest scientific findings on climate change and produces two types of reports: periodic and thematic special reports. Regular IPCC reports have been every 5 to 8 years, beginning with the First Assessment Report 1990. The Sixth Assessment Report synthesis report was released in March 2023. Policymakers worldwide cite these IPCC reports, which serve as the basis for international negotiations, including the United Nations Framework Convention on Climate Change (UNFCCC), and domestic policies.

[9] IPCC website, https://www.ipcc.ch/.
[10] IPCC, 'History of the IPCC', https://www.ipcc.ch/about/history/.

**Figure 1.1. Global Net Anthropogenic GHG Emissions (1990–2019)**

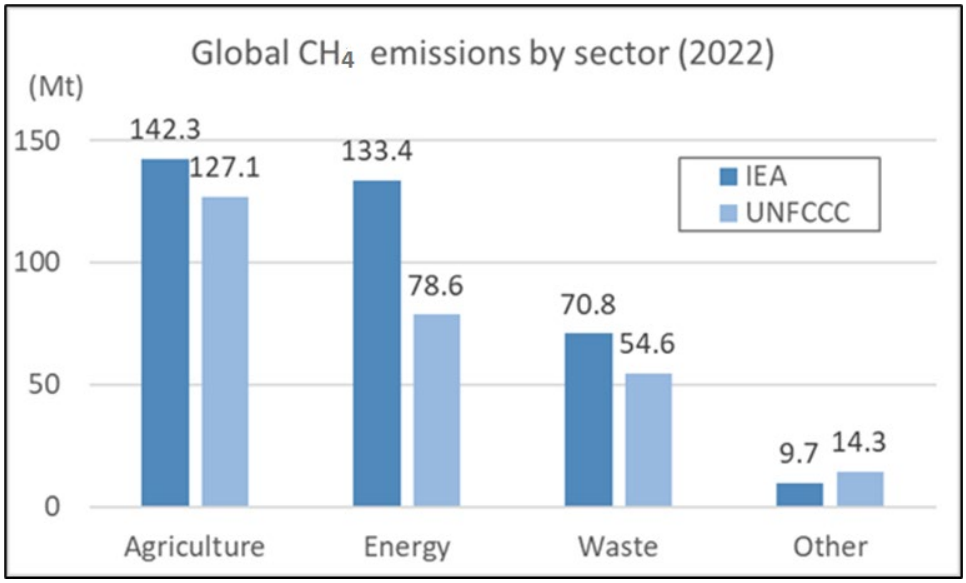



Source: IPCC Sixth Assessment Report (Working Group III) (2022).

The IPCC Sixth Assessment Report (Working Group I), published in August 2021, assessed that 'there is no doubt that the increases in atmospheric $CO_2$, $CH_4$, 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 will consist of 75% CO2 (64% of which is from fossil fuels), 18% $CH_4$, 4% $N_2O$, and the remainder 2% fluorinated gases, and others. Amongst them, $CH_4$ concentrations increased at an average rate of 7.6 ± 2.7 ppb (1 ppb = 1 mg/103 kg)/year during the last decade (2010–2019), but accelerated to 9.3 ± 2.4 ppb/year in the previous 6 years (2014–2019), with the dominant source being from human activities. In particular, since 2007, fossil fuels and agriculture (mostly from livestock) have been considered the main contributors.

### 1.2. Global Methane Tracker

**Figure 1.2. Differences in Global Methane Emissions Data (IEA vs UNFCCC) (2022)**




IEA = International Energy Agency.
Note: Some of the data contains N/A (not applicable).
Source: Compiled from IEA Methane Tracker 2023.

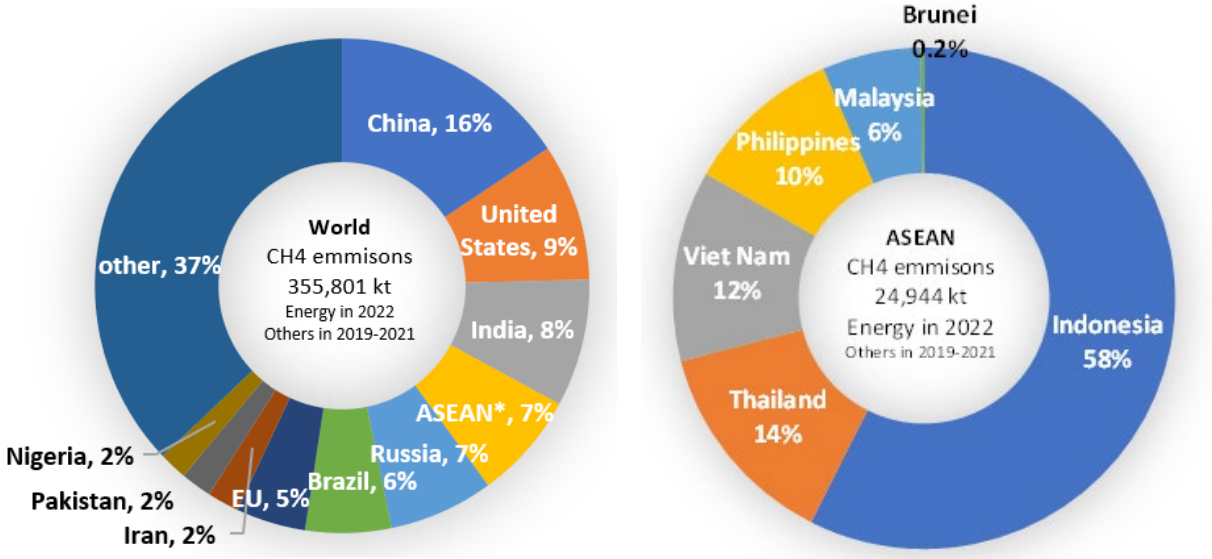
The latest version of Global Methane Tracker 2023 of the International Energy Agency (IEA), released in February 2023, covers all sources of methane from human activity. For the energy sector, these are IEA estimates for methane emissions from the supply or use of fossil fuels (coal, oil, and natural gas) and bioenergy (such as solid bioenergy, liquid biofuels, and biogases). The IEA claims its emissions estimates 'are based on the latest available scientific studies and measurement campaigns'.[11]

For non-energy sectors – waste, agriculture, and other sources – reference values based on publicly available data sources are provided to enable a fuller picture of methane sources. IEA's approach to estimating methane emissions from global oil and gas operations relies on generating country-specific and production type–specific emission intensities that are applied to production and consumption data country-by-country.

[11] IEA (2022), 'Global Methane Tracker 2022 Overview', February, https://www.iea.org/reports/global-methane-tracker-2022/overview.

According to the Global Methane Tracker, the overall CH4 emissions are larger than officially reported by governments such as the UNFCCC, and the respective aggregation methods underestimate methane emissions. In particular, the tracker claims that methane emissions from the energy sector are 70% larger than officially reported values, and reflecting actual measured values in emission factors and other data is an issue for the industry in the future.

**Figure 1.3. Global and ASEAN Methane Emissions (Share by Country) (2022)**




Notes: ASEAN comprises Brunei, Indonesia, Malaysia, Philippines, Thailand and Viet Nam.
Some of the data are not applicable (N/A).
Source: Compiled from IEA Methane Tracker 2023.

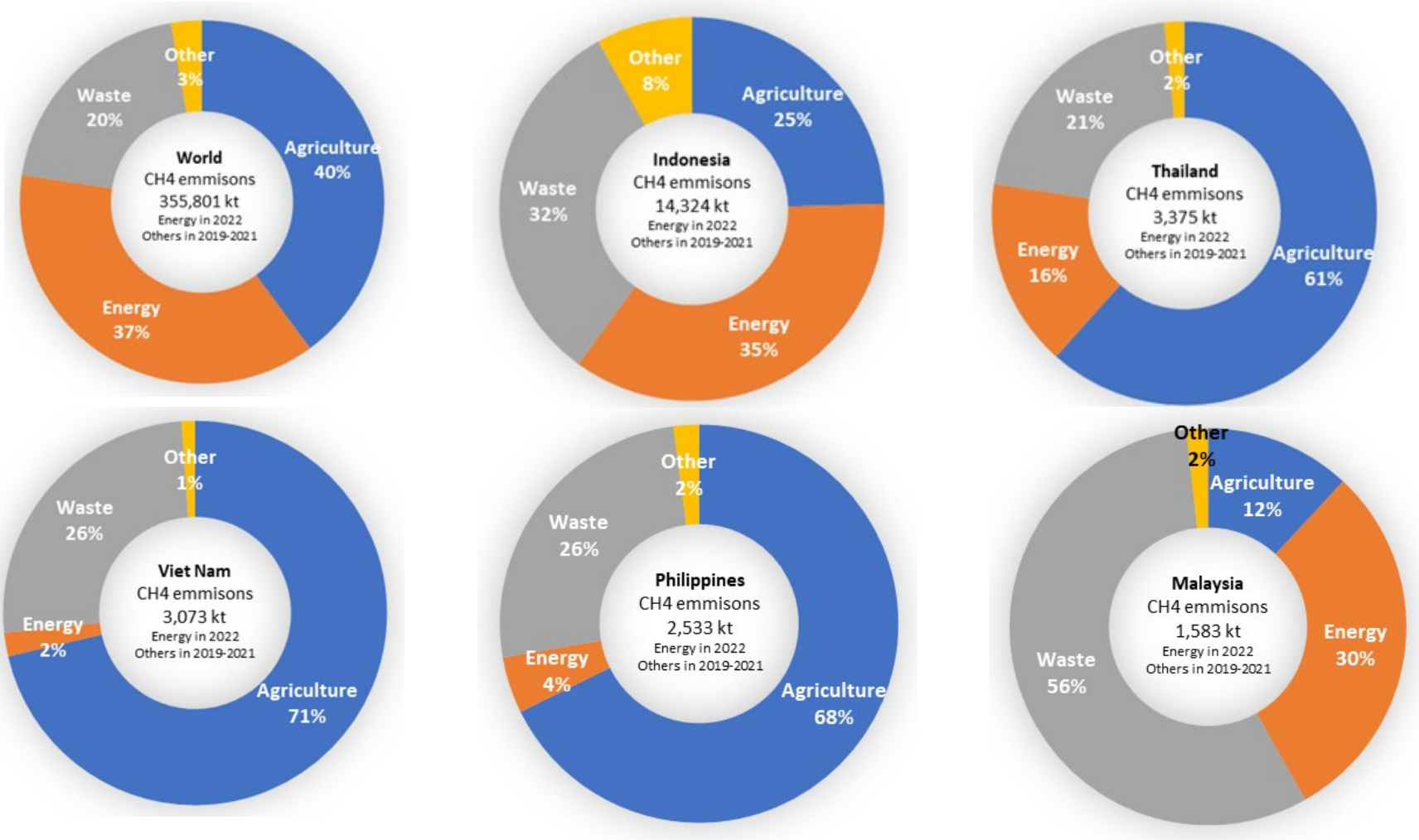
Figure 1.3 shows global methane emissions were estimated at 355.8 million tonnes in 2022, down 0.3% from 356.89 million tonnes the previous year. The largest emitter by country was China with 55.68 million tonnes (16% of the global total), followed by the US with 31.84 million tonnes (9%), India with 29.67 million tonnes (8%), and ASEAN with 24.94 million tonnes (7% of the global total). In ASEAN, Indonesia accounted for the largest share of 14.32 million tonnes (58% of the ASEAN total), followed by Thailand with 3.38 million tonnes (14%), and Viet Nam with 3.07 million tonnes (12%).

Figure 1.4 summarises methane emissions by sector (agriculture, energy, waste, and others) for the world and ASEAN countries. The largest source of CH4 emissions in the world is agriculture at 40%, followed by 37% from energy, 20% from waste, and 3% from other sources. However, the areas of focus vary depending on the situation in each country: in Indonesia, 35% comes from energy; in Thailand, 61% from agriculture; in Viet Nam, 71% from agriculture; in the Philippines, 68% from agriculture; and in Malaysia, 56% from waste.

According to the IEA, methane emissions from the energy sector totaled 133.3 million tonnes in 2022 (Figure 1.5), up 2% from 130.9 million tonnes the previous year but down from a record high of 134.7 million tonnes in 2019. Over the last 10 years, its emissions have remained largely unchanged, suggesting that the industry's and governments' efforts to reduce emissions may have been partially successful.

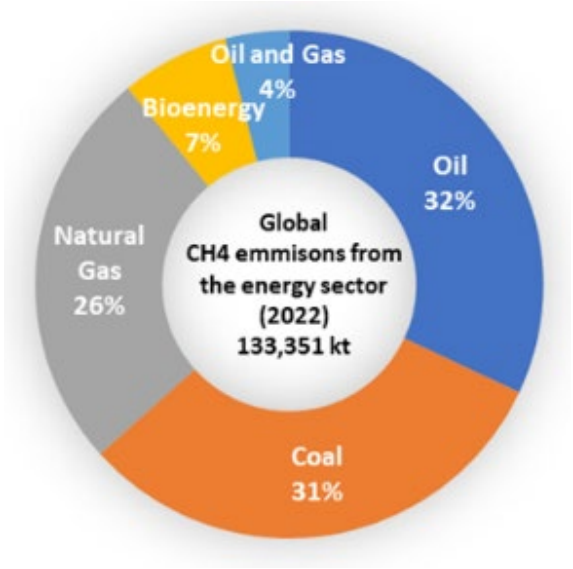
Oil, coal, and natural gas represent 32%, 31%, and 26% of the energy industry's total emissions, respectively (Figure 1.5). Regarding global methane emissions from the natural gas industry by sector, the upstream sector accounts for 65% of the total methane emissions from the natural gas industry, and the midstream and downstream sectors account for the remaining 35%. In ASEAN, the upstream sector accounts for 61%, and the midstream and downstream sectors account for 39% of the region's methane emissions in the natural gas industry.

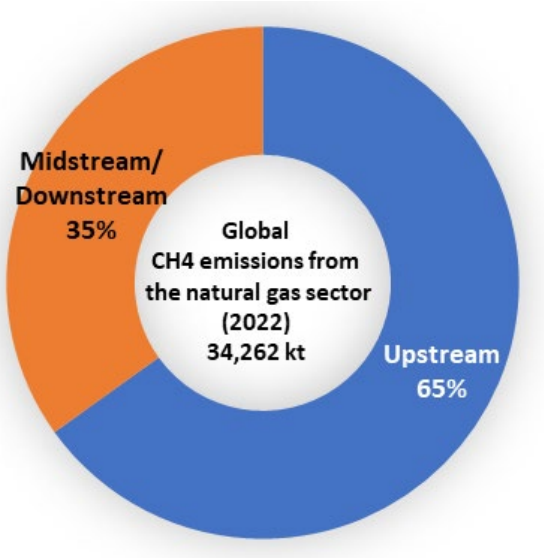
**Figure 1.4. $CH_4$ Emissions by Country (World, Indonesia, Thailand) (2022)**

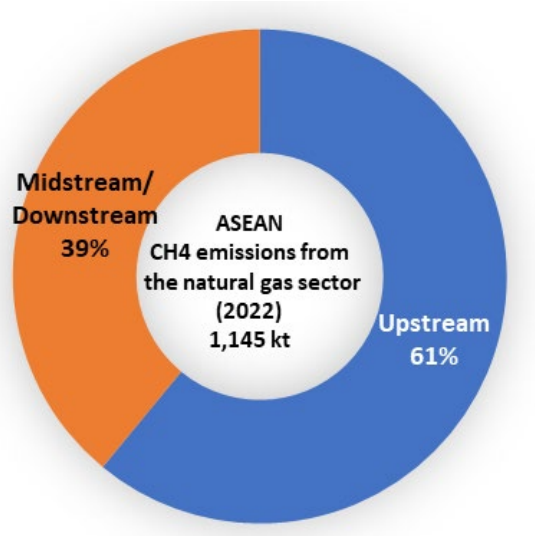



Note: Some of the data are not applicable (N/A).
Source: Compiled from IEA Methane Tracker 2023.

**Figure 1.5. Composition of Global Energy Sector CH4 Emissions (2022), Composition of CH4 Emissions in the Natural Gas Sector (World, ASEAN) (2022)**




Note: Some of the data are not applicable (N/A).
Source: Compiled from IEA Methane Tracker 2023.

## 2. Natural Gas Production and Consumption in ASEAN Countries

Table 1.2 shows that natural gas production in ASEAN is the highest in Malaysia, followed by Indonesia and Thailand, while consumption is also the highest in Malaysia, followed by Thailand and Indonesia.

According to the IEA, methane emissions in the gas sector in ASEAN are 0.52 million tonnes in Indonesia and 0.32 million tonnes in Thailand. Malaysia follows with 0.26 million tonnes.

In ASEAN, methane emissions in the natural gas sector tend to be highest in countries with increased natural gas production and consumption. However, Malaysia has the highest production and consumption and has lower methane emissions than Indonesia and Thailand. This may be due, in part, to Malaysia's advanced efforts to reduce emissions.

Meanwhile, in recent years, LNG imports have increased in Thailand, Singapore, and other countries. The Philippines and Viet Nam began importing LNG in 2023. In the coming energy transition period, natural gas consumption in ASEAN is expected to increase, making it an even more important energy source.

**Table 1.2. Natural Gas Production and Consumption by ASEAN Countries (2022)**

Unit: Billion cubic metres (bcm)

| | Production | LNG Export Volume | Pipeline Export Volume | Consumption | LNG Import Volume | Pipeline Import Volume |
|---|---|---|---|---|---|---|
| Brunei | 10.6 | 6.4 | - | - | - | - |
| Indonesia | 57.5 | 15.5 | 6.3 | 37 | - | - |
| Malaysia | 82.4 | 37.4 | - | 49.4 | 3.8 | 0.2 |
| Myanmar | 16.9 | - | 10.6 | - | - | - |
| Thailand | 25.6 | - | - | 44.3 | 11.4 | 6.6 |
| Viet Nam | 7.8 | - | - | 7.8 | - | - |
| Philippines | - | - | - | 3.1 | - | - |
| Singapore | - | - | - | 13.1 | 5.2 | 8.2 |
| Cambodia | - | - | - | - | - | - |
| Lao PDR | - | - | - | - | - | - |

Source: Compiled from 2023 The Energy Institute Statistical Review of World Energy™.

## 3. Summary of Methane Emissions

Regarding methane emissions from the energy sector, the data estimated by the IEA Methane Tracker is 70% larger than the officially reported values by governments such as the UNFCCC. This suggests that underestimated emission factors may be used in national reports and that there may be unreported (or unknown) sources of methane emissions. To conduct more appropriate methane emissions management (e.g. prioritising emission reduction measures with larger impacts and higher cost-effectiveness), it is essential to understand actual methane emission status more accurately.

Since ASEAN, as a united region, is estimated to be the fourth-largest methane emitter after China, the US, and India, methane emission reductions in ASEAN could have a significant global impact. The total methane emissions in the natural gas sector of the top three ASEAN countries is 1 million tonnes per year. If methane emissions were reduced by 40% (the IEA Methane Tracker points out that 40% of methane emissions can be addressed at zero net cost globally), 0.4 million tonnes of additional natural gas could be made available annually. This equals 2%–3% of ASEAN's LNG imports. Therefore, the methane emission reduction efforts could play a significant role in ensuring ASEAN's energy security.

ASEAN's top three methane emitters in the natural gas sector – Indonesia, Thailand, and Malaysia – are also large producers and consumers of natural gas. The relatively low methane emissions of Malaysia, which has the highest production and consumption in ASEAN, suggest that the country is progress in methane emissions management efforts. To promote methane emission management across the ASEAN region, Malaysia could lead and involve other ASEAN countries in the initiatives.

In recent years, as ASEAN has increased its natural gas consumption and LNG imports in addition to its natural gas production and LNG exports, the importance of natural gas has increased in the region as a consuming region. To sustain the use of natural gas in the energy transition period, the country needs to use natural gas more cleanly; in other words, eliminate or reduce methane emissions from the natural gas supply chain. Along with initiatives to reduce methane emissions in one's own country, it is necessary to promote the reduction of methane emissions from the entire supply chain by selecting natural gas with lower methane emissions.

# Chapter 2

# Policies for Methane Emissions Management

This chapter describes trends in methane emission management policy. The largest origins of methane emissions are the agricultural and waste management sectors. While the oil and gas industry emits methane, the emitted volumes are estimated to be smaller than agriculture's. However, methane emissions from the oil and gas industry are considered easier to address than other sources. The measures on methane emission management policy should be categorised into two types: (i) for natural gas – and LNG-producing countries, and (ii) for the consuming countries and regions, including ASEAN consumers, Japan, the Republic of Korea (henceforth, Korea), and the EU.

Recent national efforts to reduce methane emissions include a joint statement from major LNG-producing and -consuming countries. On 18 July 2023, the Government of Japan and the IEA co-hosted Japan's 12th LNG Producer–Consumer Conference (LNG PCC). At the conference, LNG-producing and -consuming countries and a region, including the US, Korea, Australia, the European Commission (EC), and Japan, announced the joint statement. The joint statement emphasises the importance of 'CLEAN', a new initiative by LNG importers introduced in Chapter 3.4 of this paper. In the joint statement, the above-mentioned LNG-producing and -consuming countries and the region expressed their commitment to work together to accelerate methane emission reductions, recognising the importance of reducing methane emissions throughout the LNG value chain from upstream to downstream and the importance of reliable measurement, monitoring, reporting, and verification of emissions and transparency of methane emissions data.

At the LNG PCC ministerial session, representatives of the countries also shared their views on national policies on LNG and methane emission reductions in the LNG value chain. Amongst the ASEAN economies, Singapore and Thailand expressed their views on methane emission reductions. Singapore mentioned the measures to reduce methane leakages from gas pipelines as one of its emission reduction efforts. Thailand said that cooperation with other major LNG-consuming countries would facilitate the exchange of knowledge, expertise, and necessary technology to advance emission reduction efforts.

## 1. The Methane Emission Policy Measures and Regulations for Nations Other than ASEAN, with Focus on the US, Europe, Australia, Canada, and Japan

### 1.1. Trends in the US

During the Obama administration, the EPA announced the New Source Performance Standards[12] for oil and natural gas source categories in August 2012. Subsequently, the Obama administration released its 'Climate Action Plan to Cut the Pollution' to curb domestic GHG emissions in June 2013 and its 'Climate Action Plan – Strategy to Reduce Methane Emissions' in March 2014. In May 2016, the EPA adopted new regulations governing methane emissions from oil and natural gas production (NSPS 2016). However, after the Trump administration took office in January 2017, the EPA withdrew the

[12] EPA, 'New Source Performance Standards and Permitting Requirements', https://www.epa.gov/controlling-air-pollution-oil-and-natural-gas-industry/new-source-performance-standards-and

NSPS 2016 regulation in August 2019 and removed methane from the transportation and storage portion of the gas industry in September 2020.

After Democratic President Biden took office in January 2021, the US Senate adopted a proposal in April 2021 to reinstate methane emission regulations, including the New Source Performance Standards (NSPS 2012 and 2016) for methane emissions from oil and gas operations set by the Obama administration. In January 2022, the US also enacted the 'US Methane Emissions Reduction Action Plan,' and in August 2022, 'Inflation Reduction Act (IRA)'. The IRA provides incentives for early implementation of methane reduction technologies and imposes emission charges on oil and gas facilities that emit more than certain thresholds. In addition, in November 2022, the EPA expanded methane regulations, requiring drillers to find and plug leaks at all domestic drilling sites and other policies to curb methane emissions rapidly.

As the previous paragraphs explain, a methane charge imposed directly on methane emissions has been introduced on the IRA for the first time in US history. Section 136 of the Clean Air Act (CAA) has been inserted by Section 60113 of the IRA in August 2022. This amendment directly imposes the charge to methane emissions. Table 2.1 explains the incentives and charges stipulated on the IRA. Section 136 of the CAA is 'Methane Emission and Waste Reduction Incentive Program for Petroleum and Natural Gas Systems'.[13]

Table 2.1 comprises two parts. The first part includes paragraphs (a) and (b). These are incentives for methane emission mitigation, including subsidies to suppliers and producers of the oil and gas industry. Paragraphs (c) to (h) are the emissions charges provisions. Section 136 of the CAA includes some incentives and emissions charges. Paragraph (c) imposes the charge to the methane emissions that exceed certain thresholds. Paragraph (f) describes the thresholds. There is an exemption for the charge, sub-paragraph (6) in paragraph (f). Facilities subject to the Standards of Performance for New Sources and Emission Guidelines for Existing Sources will be exempted from this waste emissions charge. Sub-paragraph (6) is a very significant provision for the operators. In paragraph (h), the charge calculation system shall move into an empirical data system. The EPA seems to want to change the system into empirical data systems.

However, US Republican Party lawmakers want to withdraw the methane emissions and waste incentive program. It is important to keep a close watch on future developments.

[13] EPA (2023), 'EPA Seeks Input on Methane Emissions and Waste Reduction Incentive Program for Petroleum and Natural Gas Systems', 18 May, https://www.epa.gov/newsreleases/epa-seeks-input-methane-emissions-and-waste-reduction-incentive-program-petroleum-and

**Table 2.1. Waste Emissions Charge in the US**
**(Insert of Sec. 136 in the Clean Air Act by Sec. 60113 of the Inflation Reduction Act)**

| | **SEC. 136. Methane Emissions and Waste Reduction Incentive Program** |
|---|---|
| Incentives for Methane Mitigation and Monitoring (a) | $850,000,000, to remain available until 30 September 2028 |
| Incentives for Methane Mitigation From Conventional Wells (b) | $700,000,000, to remain available until 30 September 2028 |
| Waste Emissions Charge (c) | The Administrator shall impose and collect a charge on methane emissions that exceed **an applicable waste emissions threshold** from an owner or operator of **an applicable facility** that reports more than 25,000 metric tonnes of carbon dioxide equivalent of greenhouse gases emitted per year |
| **Applicable Facilities** (d) | (1) Offshore petroleum and natural gas production<br>(2) Onshore petroleum and natural gas production<br>(3) Onshore natural gas processing<br>(4) Onshore natural gas transmission compression<br>(5) Underground natural gas storage<br>(6) Liquefied natural gas storage<br>(7) Liquefied natural gas import and export equipment<br>(8) Onshore petroleum and natural gas gathering and boosting<br>(9) Onshore natural gas transmission pipeline |
| Charge Amount (e) | (1) * (2)<br>(1) The number of metric tonnes of methane emissions reported for the applicable facility that exceed **the applicable annual waste emissions threshold** during the previous reporting<br>(2) (A) $900 for calendar year 2024<br>(B) $1,200 for calendar year 2025<br>(C) $1,500 for calendar year 2026 and each year thereafter |
| | |
| Waste Emissions Threshold (f) | (1) Petroleum and natural gas production (for an applicable facility in paragraph (1) or (2)):<br>(A) 0.20 percent of the natural gas sent to sale<br>(B) 10 metric tonnes of methane per million barrels of oil sent to sale<br>(2) Nonproduction petroleum and natural gas systems (for an applicable facility in paragraph (3), (6), (7), or(8)):<br>The reported metric tonnes of methane emissions that exceed 0.05 percent of the natural gas sent to sale |

| | |
|---|---|
| | (3) Natural gas transmission (for an applicable facility in paragraph (4), (5), or (9)):<br>The reported metric tonnes of methane emissions that exceed 0.11 percent of the natural gas sent to sale<br>(6) Exemption of for regulation compliance:<br>Charges shall not be imposed on an applicable facility that is subject to and in compliance with methane emissions requirements pursuant to subsections (b) and (d) of section 111 (Standards of Performance for New Sources and Emission Guidelines for Existing Sources)<br>(7) Plugged wells:<br>Charges shall not be imposed with respect to the emissions rate from any well that has been permanently shut-in and plugged in the previous year |
| Period (g) | The charge shall be imposed and collected beginning with respect to emissions reported for calendar year 2024 and for each year thereafter |
| Reporting (h) | Not later than 2 years after the date of enactment of Sec.136, the Administrator shall revise the requirements to ensure the reporting and calculation of charges are based on empirical data |

- Rescission of methane emissions and waste reduction incentive program may be part of House GOP bill.

Source: US Government, https://www.govinfo.gov/content/pkg/PLAW-117publ169/pdf/PLAW-117publ169.pdf.

Table 2.2 describes the New Source Performance Standards and Emission Guidelines Supplemental Proposal to Reduce Pollution from Oil and Natural Gas Operations in November 2022. The original package of New Source Performance Standards and Emission Guidelines was first proposed in November 2021. The table describes the key changes since the 2021 original proposal. The proposal in 2022 is supplemental to the original 2021 proposal.

**Table 2.2. New Source Performance Standards and Emissions Guidelines Supplemental Proposal to Reduce Pollution from the Oil and Natural Gas Operations in the US**

| | **Key Changes Since the November 2022 Proposal** |
|---|---|
| Requiring Routine Leak Monitoring at Every Wells | • All well sites are routinely monitored for leaks, with requirements (the combination of AVO (audio, visual and olfactory) and/or OGI (optical gas imaging), and frequency) and deadlines for remediation, based on the type and amount of equipment on site, while removing exemptions for well sites with lower emissions. |
| Innovation in Methane Detection Technology | • Allow the use of a broader range of advanced technologies in lieu of OGI and proposes an approach that ties the frequency of required monitoring surveys to the detection ability of the technology used.<br>• Give owners and operators the option to use continuous monitoring technologies. Owners or operators using continuous monitoring technologies would be required to determine the cause of a leak and take corrective action.<br>• Include a pathway for technology developers and others to seek approval for using advanced technologies. Once EPA approves a technology and technique, any owner or operator can use it. |
| Preventing Emissions at Abandoned and unplugged Wells | • Require documentation that well sites are properly closed and plugged before monitoring is allowed to end. |
| **Creating a Super Emitter Response Program** | • Regulatory authority or qualified third parties could notify owners and operators of regulated facilities when a super-emitting event, which is defined as emissions of 100 kilograms of methane per hour or larger, is detected.<br>• Owners and operators would be required to conduct an analysis within five days to determine the cause. Owners/operators would have to take corrective action within 10 days or develop a corrective action plan. |
| Strengthening Requirements for Flares | • Propose monitoring requirements to continuously monitor the flare to ensure that a pilot flame burns at all times, and for enclosed combustors. |
| Strengthening Requirements for Pneumatic Pumps | • Set a zero-emissions standard for pneumatic pumps (pumps should not be driven by natural gas), with exceptions limited to sites without access to electricity |
| Updating Proposed Requirements for Compressors | • Establish emission standard for dry seal compressors, which are currently unregulated, to maintain the volumetric flow rate at or below 3 standard cubic feet per minute.<br>• Update proposed requirements for wet seal centrifugal compressors. |

| | |
|---|---|
| Associated Gas from Oil Wells | • Require owners/operators of oil wells with associated gas to implement alternatives to flaring the gas, such as to route associated gas to a sales line, use the gas for fuel or another beneficial purpose, or reinject it into a well for enhanced oil recovery, unless they submit a certified demonstration that all alternatives are not feasible. |

Source: EPA (2022), 'EPA Issues Supplemental Proposal to Reduce Methane and Other Harmful Pollution from Oil and Natural Gas Operations', November, https://www.epa.gov/controlling-air-pollution-oil-and-natural-gas-industry/epa-issues-supplemental-proposal-reduce.

This 2022 proposal includes routine leak monitoring requirements at every well and innovation in methane detection technology. However, the most important and controversial issue is creating a 'Super Emitter Response Program' in the middle of Table 2.2. The regulatory authority, EPA, or qualified third parties, including environmental non-government organisations, could notify owners and operators of regulated facilities when a super emitting event – defined as an emission of 100 kg of methane per hour or larger – occurs. Then, the relevant owners and operators would be required to analyse within 5 days to determine the cause of the super emission. The relevant owners and operators would have to take corrective action within 10 days or develop a corrective action plan. Some oil and gas companies think this is a rigorous provision for their operations. This provision will be a contentious issue for developing the performance standards and emission guidelines.

The US EPA considers the production, gathering, and compression segments contribute more than half of the total methane emissions from the entire natural gas system in the country. EPA regulations for the oil and gas industry and methane waste emissions charge in the IRA focus on the production and transportation segments. The emission mitigation efforts by the oil and gas industry indeed concentrate on these segments.

The EPA seems eager to finalise these regulations before the 2023 United Nations Climate Change Conference (COP28) on 30 November 2023.

### 1.2. Trends in the European Union

In October 2020, the European Commission (EC) published the EU Methane Strategy to reduce methane emissions. The strategy outlines European and international measures to reduce methane emissions and proposes legal and non-legal measures in the energy, agriculture, and waste sectors.

In December 2021, the EC published the EU Methane Emissions Management Bill (a package of gas bills). The bill proposed three policy amendments: (i) shifting gas consumption from natural gas to renewable and low-carbon gases, (ii) reducing methane emissions in the energy sector, and (iii) energy performance of buildings. In particular, amendment (ii) on methane emission reduction regulations includes a ban on routine venting and flaring (BRVF) of fossil fuels, methane emission monitoring for EU member states, the introduction of leak detection and repair obligations (LDAR) for various companies, and supplier side regulations on imported fossil fuels. The BRVF also establishes the responsibility of suppliers to submit information on their MRV and emission reduction methods concerning imported fossil fuels.

Furthermore, in December 2022, the European Council (at the heads of state or government level) agreed in principle on a proposal to track and reduce methane emissions in the energy sector, which would introduce new MRV obligations in the oil, gas, and coal sectors. Under the proposal, oil and gas operating companies would be required to measure and report their methane emissions and third-party verification. Methane emissions from EU energy imports would also be tracked. The new rules also promote global monitoring tools to improve transparency of methane emissions from oil, gas, and coal imports into the EU. The bill's consideration now advances to negotiations between the EC, the Council, and the European Parliament.

It is widely understood that Europe is in a 'trialogue'. The three administrative organisations are the EC, the EU Council, and the European Parliament.

Table 2.3 compares the three organisations. The methane emissions reduction regulations have an important section, 'Leak Detection and Repair (LDAR)'. This section consists of the LDAR programme, survey frequency, detection limit, repair thresholds, and repair deadline. Table 2.3 shows the positions between the EU Council and the European Parliament are slightly different. There is some discord between these two organisations. The EU Council seems more generous in the proposed regulations, and the European Parliament is stricter. Some detailed points and provisions are similar between these two organisations. However, the degree of discord and similarity varies on the topics.

The last column includes 'Importer Requirements'. The EC initially proposed this and required importers to provide information on upstream methane emissions. By the end of the 2025 calendar year, the EC shall propose amendments to the 'Importer Requirements'. On the other hand, the European Parliament demands a general approach for this section. From 2026, the European Parliament would request coal, oil, and gas importers to demonstrate the imported fossil energy meets the requirements of methane emission regulations. The European Parliament seems to intend to introduce more stringent systems in 2026. This is quite a brand new, big jump from the original proposal of the EC. Because of the diversified ideas from the three bodies, it is quite uncertain whether this emission regulation to import fossil fuel remains on the final version of the EU methane emission legislation.

While regulatory frameworks and legislation processes are under consideration and underway in the US and the EU, as well as some other countries, scopes and standards of regulations and legislation may differ in different countries and jurisdictions. However, the US, the EU, and other countries are focusing on the same goals to reduce methane emissions. To a certain extent, they should be consistent with each other. The technologies employed in these reporting requirements should be based on the same sources or at least pursue compatibility. In the end, the industry players and regulators in different countries should be able to agree on the baseline requirements, such as operational practice standards for processes such as LDAR and flaring and venting practices.

Initiatives to develop unified standards for those practices have already been underway between countries and regions, including the US, the EU, and some Asian countries, including Malaysia, Singapore, Korea, and Japan, based on calls to establish such frameworks included in languages of G7 Climate, Energy and Environment Ministers' Communiqué. Those frameworks should take advantage of early initiatives of the efforts to reduce and better manage methane emissions, such as the OGMP2.0 under agreements between different LNG-producing and LNG-consuming countries and economies, respecting historical differences in industry practices and expected roles of natural gas and LNG in other countries and economies.

**Table 2.3. Summary of the Methane Emission Management Policy in the EU**

| | European Commission (December 2021) | Council of the EU (December 2022) | European Parliament (May 2023) |
|---|---|---|---|
| Subject matter and scope | | | Include the petrochemicals sector. |
| Union methane emission target | - | | The Commission to propose a binding 2030 reduction target for EU methane emissions for all relevant sectors by the end of 2025.<br>Member States should (shall) set national reduction targets as part of their integrated national energy and climate plans. |
| Leak detection and repair | LDAR programme | | Operators must submit a methane leak detection and repair programme to the relevant national authorities six months from the date of entry into force of this regulation. |
| | Survey frequency | Allow utilizing various devices used to measure emissions. | More frequent leak detection and repair surveys compared to what the Commission is proposing. |
| | Detection limit | Increase detection limit. | |
| | Repair thresholds | Increase repair thresholds.<br>The operators shall prioritise repairs of larger leaks. | |
| | Repair deadline | Operators will need to repair or replace all leaking components above certain levels immediately after detection, and no later than five days for a first attempt and 30 days for a complete repair. | Operators repairing or replacing all components found to be leaking methane immediately after the leak has been detected or no later than five days after. |
| | | Offshore oil and gas wells deeper than 700 meters will be exempt. | |

**Table 2.3. Continued**

| | European Commission (December 2021) | Council of the EU (December 2022) | European Parliament (May 2023) |
|---|---|---|---|
| Limits to venting and flaring | | In case its implementation is not possible due to further requirements such as permitting process or where the unavailability of equipment causes an exceptional delay, the implementation of the ban may be postponed by two years at most. | |
| Inactive wells | An inventory | A more gradual approach for member states with very high number of wells (40,000 or more). | |
| | A mitigation plan | Offshore wells located at water depth between 200 and 700 meters may be exempted in specific circumstances. | |
| Importer requirements | Importers shall provide the information to the competent authorities.<br>By 31 December 2025, or earlier, the Commission shall examine the application of this Article.<br>Where applicable, the Commission shall propose amendments to this Regulation to strengthen the requirements applicable to importers. | | **From 2026, importers of coal, oil and gas to be obliged to demonstrate that imported fossil energy meets the requirements in the regulation.**<br>**Imports from countries with similar requirements for methane emissions shall be exempt.** |

Sources: European Commission (2021), 'Proposal for a Regulation of the European Parliament and of The Council on Methane Emissions Reduction in the Energy Sector and Amending Regulation (EU), 15 December, https://eur-lex.europa.eu/resource.html?uri=cellar:06d0c90a-5d91-11ec-9c6c-01aa75ed71a1.0001.02/DOC_1&format=PDF;
Council of the European Union (2022), 15 December, https://data.consilium.europa.eu/doc/document/ST-16043-2022-INIT/en/pdf;
European Parliament, https://www.europarl.europa.eu/doceo/document/TA-9-2023-0127_EN.pdf.

### 1.3. Trend in Australia

Australia has been an LNG exporter and a major agricultural country. It joined the Global Methane Pledge (GMP) in October 2022.[14] Nationally Determined Contribution (NDC) has already been released for 2022, although the NDC clearly states that methane emissions are also to be reduced. There is no mention of the oil and gas sector, although the NDC clearly says that methane emissions are also targeted for reduction.

Judging from the announcement of the Australian government at the time of its participation in the GMP in October 2022, the policy and measures of Australia are a little bit focused on agriculture, the seaweed industry, livestock feed supplements, and so on.

The press release issued by the Australian government at the time of its GMP accession announced the following as its policy.

The GMP is a voluntary commitment to reduce global methane emissions across all sectors by at least 30% below 2020 levels by 2030. The government investment will include up to A$3 billion ($2 billion) from the A$15 billion ($11 billion) National Reconstruction Fund to support investment in, for example, low-emissions technologies and component manufacturing and agricultural methane reduction. Under the Powering Australia plan, the government also committed A$8 million ($6 million) for the seaweed industry to support the commercialisation of the low-emissions livestock feed supplement Asparagopsis. The second stage of the Methane Emissions Reduction in Livestock Program will provide A$5 million ($4 million) in funding to develop technologies to deliver low-emission feed supplements to grazing animals and determine their technical viability and commercial potential. In particular, because of signing the pledge, the Australian government will not legislate or introduce taxes or levies to reduce livestock emissions.

Further initiatives across the waste and energy sectors will include capturing waste methane to generate electricity and capturing or avoiding fugitives from coal mines and gas infrastructure.

Reforms to the Safeguard Mechanism, which entered into effect in July 2023, have been aimed to support emissions reductions in the industrial sector, including methane emissions from industrial and resource activities, helping ensure Australian businesses remain competitive as the world decarbonises.

Table 2.4 summarises the Australian policy for methane emission regulation. The announced policy includes reforms to the Safeguard Mechanism. This is similar to an emission trading system. The Safeguard Mechanism, which apply to the mining, oil and gas, and waste sectors, have existed since 2016.

This system introduces an intensity baseline for covered facilities. This baseline is site-specific and calculated by the historical emission data of the facilities. There is no stringent reduction target. The existing system has emission reduction funds that generate the credit the Australian government can buy. The Australian Parliament passed the Safeguard Mechanisms Amendment Bill 2023 in March 2023. This new mechanism was implemented on 1 July 2023. Some improvements and reforms were added to the old systems.

The first new mechanism is the baseline system. This mechanism introduces the decline rate for the emission intensity baseline. Its decline rate is 4.9% each year. The existing facility now on the site-

[14] Hon Christ Bowen, MP (2022), 'Australia joins Global Methane Pledge', 23 October, https://minister.dcceew.gov.au/bowen/media-releases/australia-joins-global-methane-pledge.

specific emission intensity values may be transitioned to some industry average emission system. So, the baseline system will be strict at the proper time. This baseline will be given at the international best practice levels for new facilities.

The second most important reform is when the emissions from the facilities are below the baseline. Safeguard Facilities can get tradeable safeguard mechanism credits. This is the second point of the reforms. However, international offset measurement cannot be used.

**Table 2.4. Summary of the Methane Emission Management Policy in Australia**

| | |
|---|---|
| Joined Global Methane Pledge 23 October 2022 | ● Up to $3 billion from the $15 billion National Reconstruction Fund to support investment in, for example, low emissions technologies and component manufacturing and agricultural methane reduction<br>● Under the Powering Australia plan, $8 million for the seaweed industry to support commercialization of the low-emissions livestock feed supplement Asparagopsis<br>● The second stage of the Methane Emissions Reduction in Livestock (MERiL) Program will provide $5 million in funding to develop technologies to deliver low emission feed supplements to grazing animals<br>● **Reforms to the Safeguard Mechanism** will support emissions reductions in the industrial sector, including reductions of methane emissions from industrial and resource activities |
| Safeguard Mechanism Reforms | ● In place since 2016<br>• Apply to facilities across the mining, manufacturing, transport, oil, gas and waste sectors that emit more than 100,000 tonnes of carbon dioxide equivalent in a year<br>• Set production-adjusted (intensity) baselines of covered Safeguard facilities. A site-specific emissions intensity value set using historic data.<br>• Emission Reduction Fund (ERF) projects can generate and sell credits (Australian Carbon Credit Unit (ACCUs)) or enter into contracts for Government purchase of ACCUs<br>● The Safeguard Mechanism (Crediting) Amendment Bill 2023 was passed on 30 March 2023. Legislative rules were registered on 5 May 2023. The reformed Safeguard Mechanism will commence from 1 July 2023.<br>• The existing production adjusted (intensity) baseline setting framework will be retained. **The decline rate will be set at 4.9 per cent each year to 2030.**<br>• Baselines for existing facilities will be set using a hybrid model initially weighted towards the use of site-specific emissions intensity values, transitioning to industry average emissions intensity values by 2030.<br>• All new facilities will be given baselines set at international best practice levels<br>• Crediting and trading: **Safeguard facilities automatically generate tradable Safeguard Mechanism Credits (SMCs) when their emissions are below their baseline.** The Government may consider allowing access to high integrity international offsets at some future time. |

Source: Australian Government, https://minister.dcceew.gov.au/bowen/media-releases/australia-joins-global-methane-pledge, https://www.dcceew.gov.au/sites/default/files/documents/safeguard-mechanism-reforms-factsheet-2023.pdf.

### 1.4. Trends in Canada

Canada joined the GMP in November 2021 – at the time of GMP's inauguration – and made a non-binding pledge to reduce methane emissions by 30% from 2020 levels by 2030 per the GMP. The NDC was also updated in April 2021, and the company has published an enhanced version of the NDC compared to its previous content. The previous NDC called for a 30% reduction in GHG emissions by 2030 compared to 2005. The new target is a 40%–45% reduction from the 2005 level by 2030.[15]

Table 2.5 briefly explains Canada's methane emission management policy. Canada announced its latest methane strategy in September 2022, which targets to mitigate methane emissions of 35% by 2030 compared to 2020. For the oil and gas sector, the reduction target is 40%–45% from the emissions in 2012 by 2025. Canada strengthens the methane emissions mitigation target to at least 75% lower by 2030. The second column of Table 2.5 is the proposed regulatory framework to reduce oil and gas methane emissions, announced in November 2022. This includes a proposed source-by-source approach and performance-based elements. However, this draft regulation is not yet enforced. The draft regulation shall be released by the end of 2023.

**Table 2.5. Summary of Canada's Methane Emission Management Policy**

| | |
|---|---|
| Canada's Methane Strategy<br><br>September 2022 | ● Provides a pathway to further reduce methane emissions from across the economy, including oil and gas, landfills/waste, and agriculture<br>• With the methane reduction measures and supporting programs outlined in this strategy, Canada will be able to reduce domestic methane emissions by more than 35% by 2030, compared to 2020<br>• Oil and Gas<br>• Federal methane regulations were published in 2018 to reduce oil and gas methane emissions from 2012 levels by 40-45% by 2025<br>• An Emissions Reduction Fund was created to invest in green technologies to lower or eliminate methane and other GHG emissions from the oil and gas sector<br>• Strengthening methane regulations are being developed to achieve at least a 75% reduction of oil and gas methane emissions by 2030 from 2012 levels |
| Proposed regulatory framework for reducing oil and gas methane emissions | ● Published a proposed methane regulations framework to reduce oil and gas methane emissions by at least 75% by 2030<br>• Proposed Source-by-Source Approach<br>• By expanding the scope of the existing regulations to apply to a wider set of sources, eliminating exclusions, and driving as many individual sources as possible toward zero emissions |

[15] Government of Canada (2022), 'Faster and Further: Canada's Methane Strategy', September, https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/reducing-methane-emissions/faster-further-strategy.html.

| | |
|---|---|
| November 2022 | • Performance-based elements<br>  • The key to effective performance-based regulation is understanding actual emissions and incorporating standard emissions monitoring methods, with comprehensive recordkeeping and reporting requirements. Extending these concepts could allow for near-continuous monitoring of all methane emissions at a facility-level.<br>● The draft regulations will be published in 2023 |

Source: Government of Canada, https://publications.gc.ca/site/archivee-archived.html?url=https://publications.gc.ca/collections/collection_2022/eccc/En4-491-2022-eng.pdf; Government of Canada (2022), 'Proposed Regulatory Framework for Reducing Oil and Gas Methane Emissions to Achieve 2030 Target', November, https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/reducing-methane-emissions/proposed-regulatory-framework-2030-target.html.

### 1.5. Trends in Japan

Japan also endorsed the GMP in November 2021, as Canada did at the time of GMP's inauguration, and pledged voluntary mitigation of methane emissions at least 30% below 2020 levels by 2030. According to government figures, the country's total methane emissions have been reduced by about 35% since fiscal year 1990. In November 2022, Japan joined the Joint Declaration from Energy Importers and Exporters on Reducing Greenhouse Gas Emissions from Fossil Fuels.[16] In December 2022, Japan held the 1st Roundtable of QUAD Methane Reduction in the Natural Gas Sector to share knowledge amongst experts and practitioners. In September 2022, the Ministry of Economy, Trade and Industry (METI) concluded the memorandum of cooperation (MoC) with Petronas, Malaysia's national energy company, to promote cooperation in technologies for using clean LNG, including methane measurements. Under this MoU, JOGMEC has been discussing with Petronas about methane emission management. The cooperation outcome includes the launch of the ASEAN Methane Leadership announcement in late June 2023.[17]

As an initiative of the Ministry of Environment (MOE), Japan, there is the Greenhouse Gas Emissions Calculation, Reporting and Publication System (SHK System). The SHK (Japanese acronym of Calculation, Reporting, and Publication) system is based on the Act on Promotion of Global Warming Countermeasures, which requires businesses that emit more than a certain amount of GHGs to calculate their emissions and report them to the government, and the government publishes the said information. Since introducing the SHK system in 2006, the activities subject to calculation in the national inventory have been reviewed every year based on the actual emissions and the latest scientific findings. On the other hand, the activities covered by the SHK system were rarely reviewed. There was a situation where the activities covered by the national inventory and those covered by the SHK system had discrepancies. In January 2022, MOE and METI established the 'Study Group on

[16] Ministry of Foreign Affairs of Japan (2022), 'Report of COP27', 22 November, https://www.mofa.go.jp/mofaj/ic/ch/page1_001420.html (in Japanese).

[17] PETRONAS (2023), 'PETRONAS Collaborates with Partners to Accelerate Methane Emissions Reduction', 27 June, https://www.petronas.com/media/media-releases/petronas-collaborates-partners-accelerate-methane-emissions-reduction.

Calculation Methods in the SHK System', which held five discussion sessions on the review of calculation methods and released an interim summary in December 2022. Based on the scheduled review of the global warming potential (GWP) used in the national inventory, the summary indicated that the GWP used in the SHK system will be 28 after the review instead of the current 25, starting from the 2024 report (on emissions in 2023) for methane.

Under the Law Concerning the Promotion of the Measures to Cope with Global Warming, businesses that emit 3,000 tonnes of $CO_2$ equivalent or more per year; only Scope 1 is covered must report their methane emissions. However, many companies in Japan voluntarily disclose emissions below the standard in their sustainable reports.

**Table 2.6. Methane Emissions Disclosure by Japanese Companies (2017–2021)**

| (Tonnes) | | | $CH_4$-t | | | | | $CO_2e$-t | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Industy | No. | Company | 2017 | 2018 | 2019 | 2020 | 2021 | 2017 | 2018 | 2019 | 2020 | 2021 |
| City Gas | 1 | Tokyo Gas | 425 | 354 | 323 | 290 | 290 | 11,000 | 9,000 | 8,000 | 7,000 | 7,000 |
| | 2 | Osaka Gas | 77 | 88 | 106 | 58 | 62 | 1,925 | 2,200 | 2,650 | 1,450 | 1,553 |
| | 3 | Toho Gas | 22 | 19 | 191 | 16 | 36 | 546 | 468 | 4,766 | 408 | 891 |
| | 4 | Shizuoka Gas | 7 | 7 | 7 | 7 | | 170 | 170 | 176 | 176 | |
| | 5 | Hiroshima Gas | 11 | 26 | 9 | 10 | 10 | 275 | 650 | 225 | 250 | 250 |
| | 6 | Saibu Gas | 10 | 10 | 9 | 9 | 7 | 250 | 250 | 225 | 225 | 175 |
| Electric Power | 1 | JERA | - | - | 400 | 400 | 400 | - | - | 10,000 | 10,000 | 10,000 |
| | 2 | Hokuriku | 20 | 23 | 21 | 20 | 23 | 500 | 575 | 525 | 500 | 582 |
| | 3 | Chugoku | - | - | - | 240 | 320 | - | - | - | 6,000 | 8,000 |
| | 4 | Kyushu | 8 | 0 | 0 | 4 | 8 | 200 | 0 | 0 | 100 | 200 |
| Development | 1 | INPEX（Domestic） | 556 | 1,040 | 1,400 | 640 | 560 | 13,892 | 26,000 | 35,000 | 16,000 | 14,000 |
| | | 〃 （Total） | 577 | 5,120 | 13,160 | 9,160 | 4,880 | 14,417 | 128,000 | 329,000 | 229,000 | 122,000 |
| | 2 | JAPEX（Domestic） | 5,725 | 3,823 | 2,519 | 1,514 | 1,114 | 143,113 | 95,586 | 62,975 | 38,000 | 28,000 |
| | | 〃 （Total） | 5,725 | 3,828 | 2,519 | 1,533 | 1,119 | 143,113 | 95,699 | 62,975 | 38,480 | 28,120 |
| Oil | 1 | ENEOS | 1,659 | 1,690 | 1,868 | 1,713 | 1,897 | 41,480 | 42,259 | 46,691 | 42,814 | 47,431 |
| | 2 | Idemitsu | - | - | 1,986 | 14,531 | | - | - | 49,650 | 363,275 | |
| Trading | 1 | Mitsubishi (MC) | 37,680 | 36,800 | 34,800 | 33,600 | 68,880 | 942,000 | 920,000 | 870,000 | 840,000 | 1,722,000 |
| | 2 | Mitsui & Co. | 71,840 | 36,320 | 39,880 | 55,120 | 53,440 | 1,796,000 | 908,000 | 997,000 | 1,378,000 | 1,336,000 |
| | 3 | ITOCHU | - | 0 | 58 | 4,729 | 5,435 | - | 0 | 1,459 | 118,224 | 135,884 |

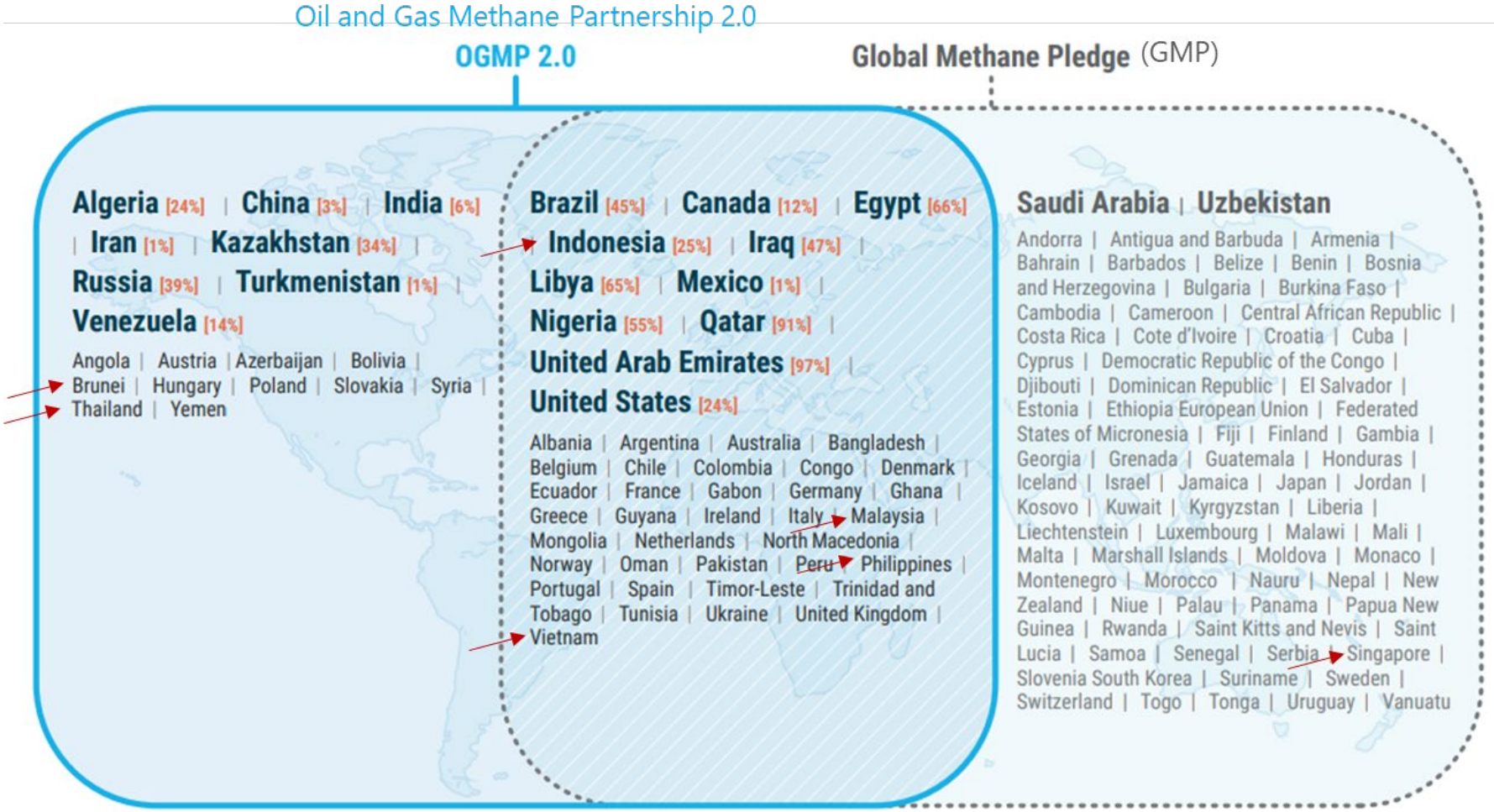
Note: Blanks indicate undated data.
Source: Compiled from company data.

In recent years, many companies have begun to disclose their emissions due to the growing importance of methane emissions management worldwide. In addition, some companies have subdivided their emissions reporting items and are now publishing emissions by factor and gas type, as well as by domestic and overseas emissions. Furthermore, some companies, mainly trading companies, have expanded the scope of emissions and are gradually compiling and disclosing GHGs other than energy-derived $CO_2$ to include '$CH_4$ from swine rearing and waste management,' '$CH_4$ from wastewater treatment', and '$CH_4$ from waste composting and landfill disposal'.

## 2. The Methane Emission Management Policy and Regulations in ASEAN Economies

Several ASEAN nations – Indonesia, the Philippines, Thailand, and Viet Nam – have joined the Global Methane Initiative (GMI). Indonesia, Malaysia, the Philippines, Singapore, and Viet Nam have endorsed the GMP. Figure 6 describes the participation status of countries for GMP and Oil and Gas Methane Partnership 2.0 (OGMP2.0). In the case of OGMP2.0, the countries indicated in Figure 6 mean those countries host assets operated by the OGMP2.0 member companies, rather than the participations of governments.

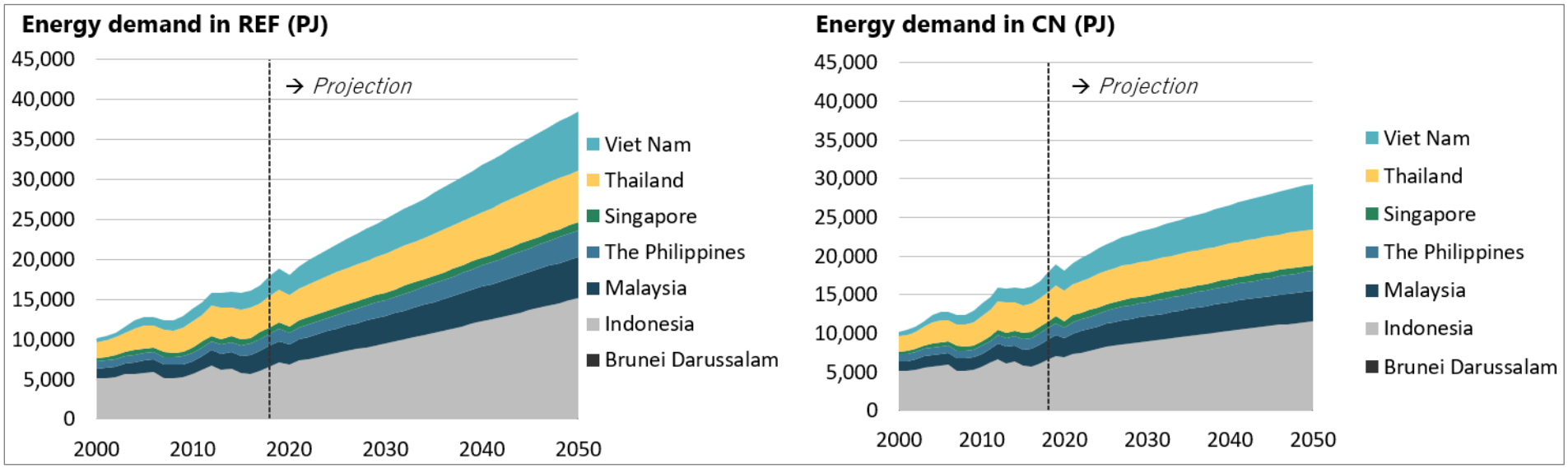
**Figure 2.1. The Participation Status of Countries for GMP and OGMP2.0**




Source: OGMP 2.0.

Only the Lao PDR does not have apparent natural gas consumption in reliable statistics. The other ASEAN nations are suspected to, more or less, have methane emissions originating from natural gas supply systems. ASEAN has been experiencing significant economic development in recent years, and energy demand is expected to increase as gross domestic product grows. Figure 2.2 shows the energy demand forecasts by the Asia Pacific Energy Research Centre (APERC) for seven nations in Southeast Asia. There are two scenarios in the figure. One on the left-hand side is based on the reference scenario where energy demand will grow more than double in 2050. The one on the right-hand side is based on the carbon neutrality scenario, where energy is expected to be used more efficiently. However, energy demand is still expected to grow. The region's economies are developing rapidly, and energy consumption and GHG emissions are expected to grow.

**Figure 2.2. Energy Demand Forecasts for Seven Southeast Asian Nations**




Source: Thanan Marukatat, Senior Researcher, APERC. Page 6 of presentation material, 'Southeast Asia's Climate Policy Overview', at the ERIA Workshop on 'Effective Management of Methane Emission in ASEAN' on 28 June 2023.

The ASEAN region is undergoing remarkable economic development, and energy consumption is expected to increase. Some countries filed their NDCs in the previous year (Table 2.7). Table 2.7 summarises the GHG emission targets from the NDC. All Southeast Asia nations submit NDCs. Singapore, Thailand, and Viet Nam, at the bottom, for example, submitted their NDCs in November 2022. And on the third column left, most nations target their emission reduction against the business-as-usual baseline. On the right-end column, reduction target ranges are very different amongst countries.

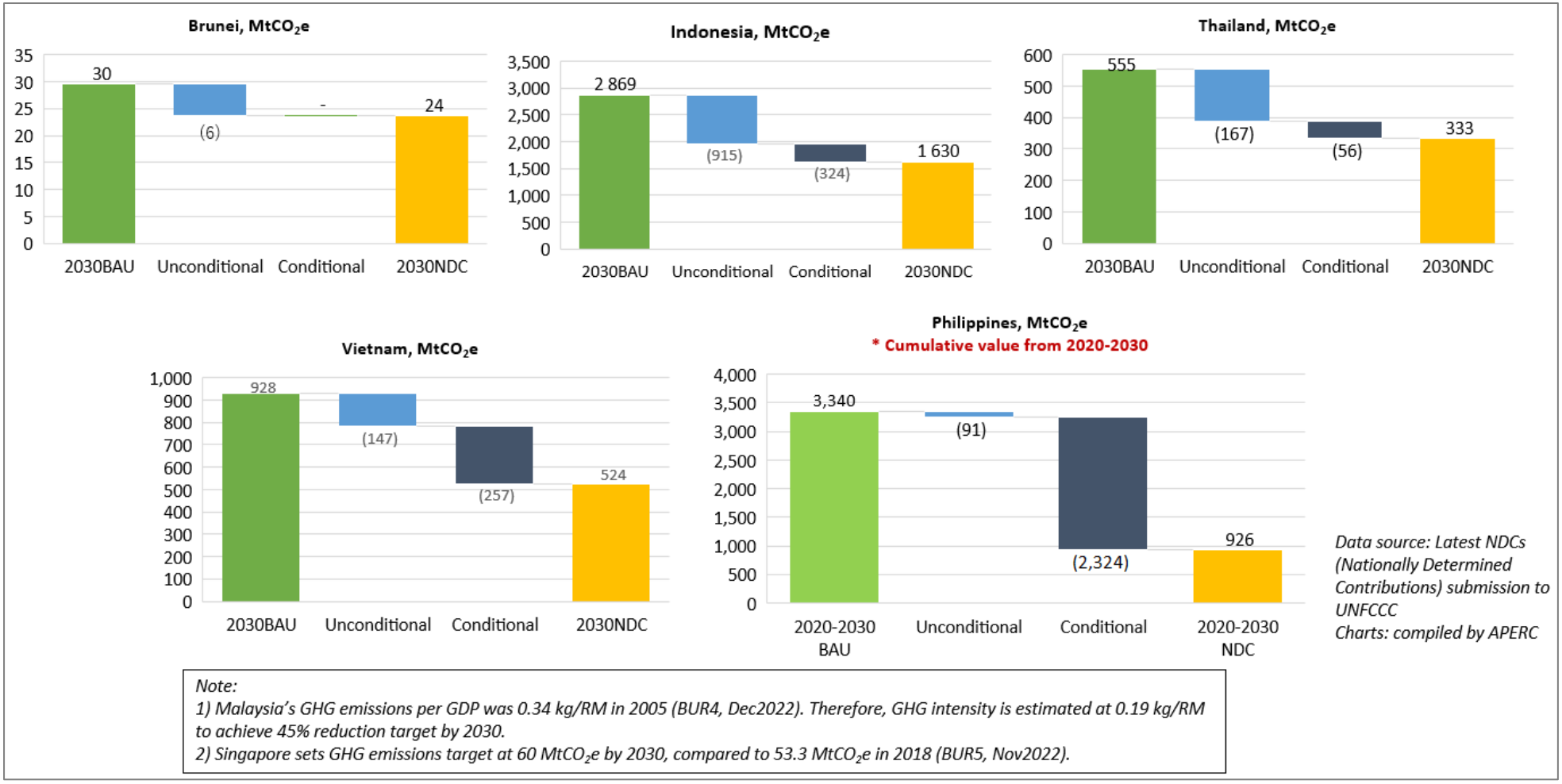
**Table 2.7. Nationally Determined Contribution Targets in ASEAN**

| Economy | Submission | Target Type | GHG Emissions Type | Unconditional | Conditional |
|---|---|---|---|---|---|
| Brunei Darussalam | 31-Dec-20 | Emission reduction relative to a business-as-usual (BAU) baseline | **$CO_2$, $CH_4$, $N_2O$** | 20% | - |
| Indonesia | 23-Sep-22 | Emission reduction relative to a BAU baseline | **$CO_2$, $CH_4$, $N_2O$** | 31.89% | 43.2% |
| Philippines | 15-Apr-21 | Emission reduction relative to a BAU baseline | **$CO_2$, $CH_4$, $N_2O$**, PFCs, HFCs | 2.71% | 72.29% |
| Thailand | 2-Nov-22 | Emission reduction relative to a BAU baseline | **$CO_2$, $CH_4$, $N_2O$**, HFCs, PFCs, $SF_6$ | 30% | 40% |
| Viet Nam | 8-Nov-22 | Emission reduction relative to a BAU baseline | **$CO_2$, $CH_4$, $N_2O$**, HFCs | 15.8% | 43.5% |
| Malaysia | 30-Jul-21 | **Carbon intensity** (against GDP) in 2030 compared to 2005 | **$CO_2$, $CH_4$, $N_2O$**, HFCs, PFCs, $SF_6$, $NF_3$ | 45% | - |
| Singapore | 4-Nov-22 | **Maximum emission** | **$CO_2$, $CH_4$, $N_2O$**, HFCs, PFCs, $SF_6$, $NF_3$ | 60 $MtCO_2e$ | |

Source: Thanan Marukatat, Senior Researcher, APERC. Page 8 of his presentation material, 'Southeast Asia's Climate Policy Overview', at the ERIA Workshop on Effective Management of Methane Emission in ASEAN' on 28 June 2023.

The GHG reduction targets in each NDC have been translated into Figure 2.3. The vertical axis of Figure 2.3 displays the GHG emissions in million tonnes of $CO_2$ equivalent. The scale is different amongst nations. The pathway to reach the target varies in each country. However, some nations need support (Table 2.8).

**Figure 2.3. Profile of GHG Emission Reduction Targets by Economy**




Source: Thanan Marukatat, Senior Researcher, APERC. Page 9 of his presentation material, 'Southeast Asia's Climate Policy Overview', at the ERIA Workshop on 'Effective Management of Methane Emission in ASEAN', on 28 June 2023.

**Table 2.8. Required Support in the Energy Sector to Meet the 2030 Targets, as Indicated in NDCs**

| | Financial | Technology | Capacity Building |
|---|---|---|---|
| Indonesia | $246 billion | - RE technology (PV, pumped storage, wind, and bioenergy)<br>- Improvement of public transport<br>- High energy efficiency in industry sector | - Capacity building of government, private, and public sectors in implementing emission reduction measures |
| Thailand | (not specified) | - RE technology (solar, wind)<br>- Advanced energy storage systems (EV, batteries, and infrastructure)<br>- CCS and CCUS technologies<br>- Green hydrogen/bio-hydrogenated diesel | - Development of data collection, reporting, and country-specific emission factors |
| Viet Nam | $35.9 billion | - Optimal process for coal-fired thermal power plants<br>- RE development (solar, biomass)<br>- Power transmission and distribution | - Data collection tool kit for GHG inventory<br>- Measurement, reporting and verification (MRV) system at sectoral and local levels |

CCS = carbon capture and storage; CCUS = carbon capture, utilisation, and storage; EV = electric vehicle; GHG = greenhouse gas; NDC = Nationally Determined Contribution; PV = photovoltaic, RE = renewable energy.
Source: Thanan Marukatat, Senior Researcher, APERC. Page 10 of his presentation material, 'Southeast Asia's Climate Policy Overview', at the ERIA Workshop on 'Effective Management of Methane Emission in ASEAN' on 28 June 2023.

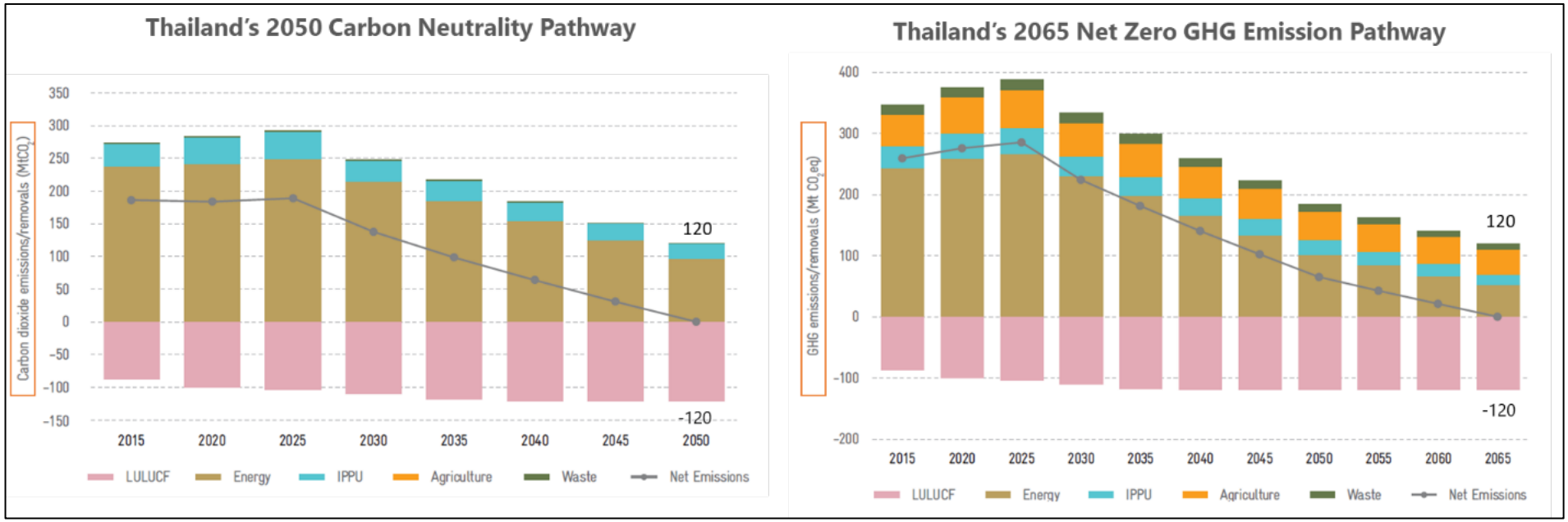
Some Southeast Asian economies need financial, technological, and capacity building to support the achievement of the reduction targets. For example, Indonesia states that the total expenditure required to achieve the target is $246 billion. In addition, Indonesia has identified specific technology and capacity-building needs, such as renewable technology, the improvement of public transport, the infrastructure improvement in the power sector, etc. On the other hand, Thailand did not specify its financial need but also the need for technology and capacity building. At the bottom, Viet Nam estimates $35.9 billion is required to meet the unconditional reduction with additional technology support such as optimising coal-fired power generation, developing renewable energy, and upgrading power transmission and distribution. Almost all countries in capacity building also address data collection and reporting.

Two countries, Thailand and Viet Name, are examined for better understanding. Malaysia is explained as Petronas in Chapter 4.

### 2.1. Trends in Thailand

Figure 2.4 represents Thailand's $CO_2$ and GHG reduction policies. The left-hand side figure shows the carbon neutrality pathway focusing only on $CO_2$ emissions. Thailand aims to reduce the total gross $CO_2$ emission to 120 million tonnes in 2050. The forestation provides an absorption capacity of a negative under 120 million tonnes, making Thailand a net-zero carbon emission country in 2050. On the right side of Figure 2.4 is a GHG emission pathway, which includes the estimated methane from agriculture and waste. The top two portions of the figure show methane emissions. The pathway aims for gross GHG emission of 120 million tonnes again in 2065, to be offset by the same forestation to make the GHG emission neutral.

**Figure 2.4. Policy Directions for CO2 Reduction in the Carbon-neutral Pathway and Methane Reduction in the Net-zero GHG Pathway**

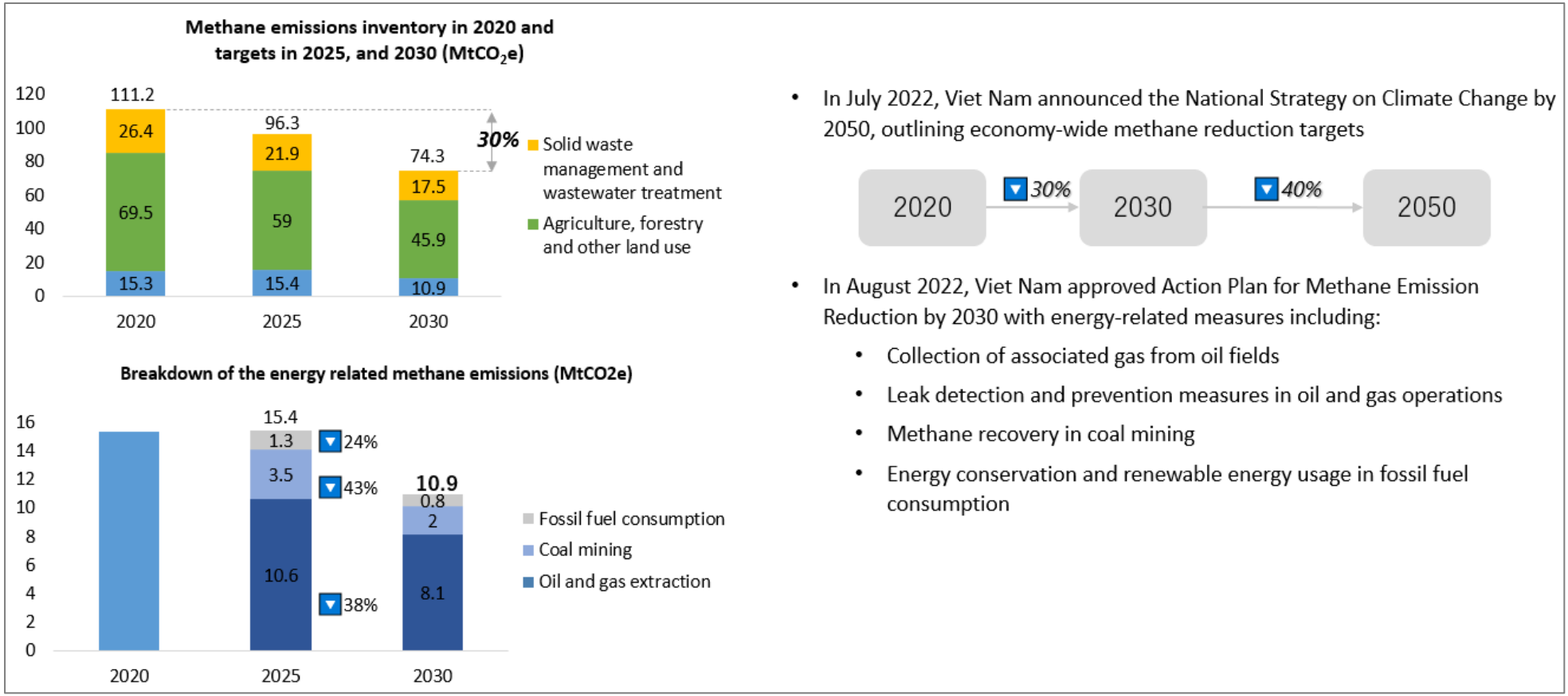



Source: Thanan Marukatat, Senior Researcher, APERC. Page 14 of his presentation material, 'Southeast Asia's Climate Policy Overview' at the ERIA Workshop on 'Effective Management of Methane Emission in ASEAN' on 28 June 2023.

## 2.2. Trends in Viet Nam

Figure 2.5 shows Viet Nam's strategies for climate change. Viet Nam has announced an interesting national climate change policy. The strategy provides an action plan specifically for methane reduction. In July 2022, Viet Nam announced the national strategy to mitigate methane emissions by 30% in 2030 compared to 2020, shown at the top of the bar charts. And further than that, in August 2022, Viet Nam announced another action plan for a methane reduction programme specifically for the energy sector, shown on the bottom bar chart. The bottom graph shows the total methane emission target of 10.9 million tonnes by 2030, consisting of 8.1 million tonnes from oil and gas extraction, 2 million tonnes from coal mining, and 0.8 million tonnes from fossil fuel consumption. This is the maximum target emission of methane in Viet Nam.

**Figure 2.5. National Strategies on Climate Change, Action Plans for Methane Mitigation (Viet Nam)**




Source: Thanan Marukatat, Senior Researcher, APERC. Page 15 of his presentation material, 'Southeast Asia's Climate Policy Overview', at the ERIA Workshop on 'Effective Management of Methane Emission in ASEAN' on 28 June 2023.

## 3. Conclusion on Government Policies

Looking at the methane emission management (and climate change control) policies of the US, the EU, and ASEAN countries, as the impact of methane emissions on climate change may sometimes be greater than $CO_2$ emissions, many countries have endorsed the GMP. The importance of measurement, reporting, and certification can also be seen from the growing membership of oil exploration and production companies and other companies in OGMP2.0, indicating that methane reduction is being recognised at the industry and national levels.

However, few governmental policy measures target only methane regulations, rather than policies to reduce GHGs as a whole. Policies focused on methane emissions and leakages may lead to meaningful methane emissions reductions, which have higher global warming effects.

In addition, if methane emission reductions are focused on the oil and gas industry, setting targets for each upstream (exploration and production), midstream (storage and transportation, as well as LNG production, transportation, and regasification), and downstream (delivery and consumption) stages could have a great deal of effect. However, setting targets involves setting numerical values. Since measurement and reporting standards have not been unified and harmonised yet on a global or regional basis, comparisons with others may be impractical.

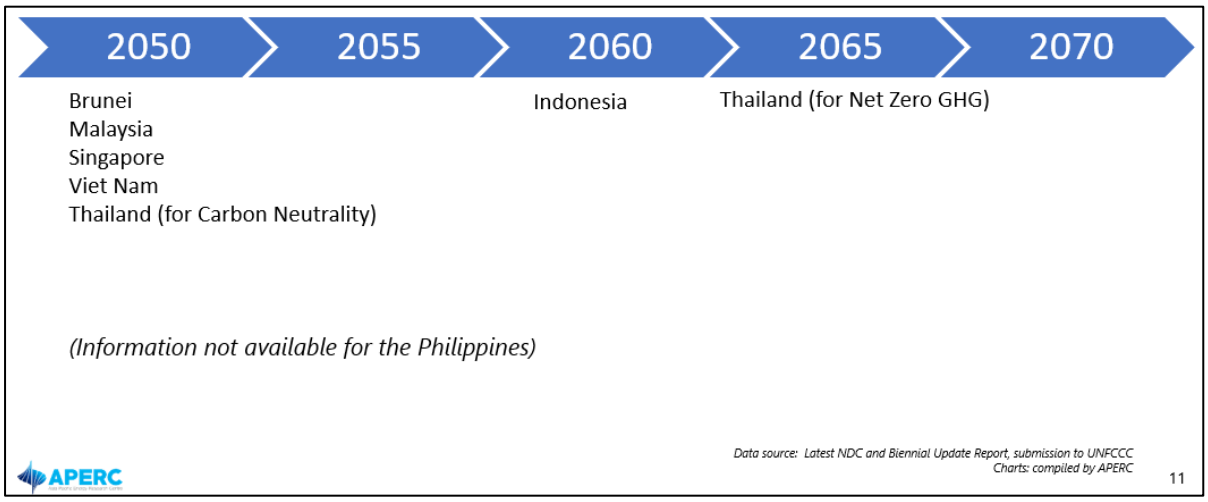
Until unified measurement and reporting standards are established, or at least some comparison measures are introduced, it may be appropriate to require that increases and decreases be measured at fixed points on a corporate or site basis and that emissions mitigation measures be taken. In addition, from the standpoint of fairness, the achievement or non-achievement of these standards should be firmly supervised as a government policy, and incentives and penalties may be introduced or established.

**Table 2.9. Summary of NDCs in Selected ASEAN Countries**

| Economy | Submission | Target Type | GHG Emissions Type | Unconditional | Conditional |
|---|---|---|---|---|---|
| Brunei Darussalam | 31-Dec-20 | Emission reduction relative to a business-as-usual (BAU) baseline | **$CO_2$, $CH_4$, $N_2O$** | 20% | - |
| Indonesia | 23-Sep-22 | Emission reduction relative to a BAU baseline | **$CO_2$, $CH_4$, $N_2O$** | 31.89% | 43.2% |
| Philippines | 15-Apr-21 | Emission reduction relative to a BAU baseline | **$CO_2$, $CH_4$, $N_2O$**, PFCs, HFCs | 2.71% | 72.29% |
| Thailand | 2-Nov-22 | Emission reduction relative to a BAU baseline | **$CO_2$, $CH_4$, $N_2O$**, HFCs, PFCs, $SF_6$ | 30% | 40% |
| Viet Nam | 8-Nov-22 | Emission reduction relative to a BAU baseline | **$CO_2$, $CH_4$, $N_2O$**, HFCs | 15.8% | 43.5% |
| Malaysia | 30-Jul-21 | **Carbon intensity** (against GDP) in 2030 compared to 2005 | **$CO_2$, $CH_4$, $N_2O$**, HFCs, PFCs, $SF_6$, $NF_3$ | 45% | - |
| Singapore | 4-Nov-22 | **Maximum emission** | **$CO_2$, $CH_4$, $N_2O$**, HFCs, PFCs, $SF_6$, $NF_3$ | 60 $MtCO_2e$ | |

Source: Thanan Marukatat, Senior Researcher, APERC. Page 8 of his presentation material, 'Southeast Asia's Climate Policy Overview' at the ERIA Workshop on 'Effective Management of Methane Emission in ASEAN' on 28 June 2023.

**Figure 2.6. Summary of Net-zero Targets in Selected ASEAN Countries**




Source: Thanan Marukatat, Senior Researcher, APERC. Page 11 of his presentation material, 'Southeast Asia's Climate Policy Overview' at the ERIA Workshop on 'Effective Management of Methane Emission in ASEAN' on 28 June 2023.

**Table 2.10. Summary of Related GHG Policies, Regulations, and Legislative Measures in Selected Countries and Regions**

| | Law/ Regulation /Reference | Contents /Points | Reporting Obligation | Incentive | Penalty | Numerical Targets for Methane Mitigation | GMP |
|---|---|---|---|---|---|---|---|
| United States | Sec. 136 of the Clean Air Act (Inflation Reduction Act) | US EPA focuses on the entire natural gas system. | Facility Controller | Financial and Technical Assistance for Mitigation | Excess Threshold Volume x Charge Rate | Based on GMP (at least 30% mitigation in 2030 compared to 2020) | YES |
| European Union (EU) | Under consideration amongst the European Commission, Council of EU, and European Parliament | Slight disagreements on the degree of Leak Detection and Repair (LDAR): survey frequency, detection limit, repair-related matters, and so on | Facility Controller, Importer of coal, oil, and gas | NA | NA | Based on GMP | YES |
| Australia | Safeguard Mechanism | Not particular to methane emission. Overall GHG emission is target. Baseline Credit decreases by 4.9% each year to 2030. | Facility Controller | 'Safeguard Mechanism Credits (Australian Carbon Credit Unit)' can be sold at Emission Trading System. | The amount exceeds the baseline credit allocated to each facility must be purchased at Emission Trading System. | Based on GMP | YES |
| Canada | New regulation to be released in 2023 | Source-by- source approach to be adopted. | The concept is near-continuous monitoring of all methane emissions at a facility level. | NA | NA | More than 35% mitigation by 2030 compared to 2020. Especially for | YES |

| | Law/ Regulation /Reference | Contents /Points | Reporting Obligation | Incentive | Penalty | Numerical Targets for Methane Mitigation | GMP |
|---|---|---|---|---|---|---|---|
| | | | | | | the oil and gas sector, 40%~45% mitigation by 2025 compared to 2012. | |
| Japan | Act on Promotion of Global Warming Countermeasures | The act requires businesses to calculate their emissions and report them to the government. National inventory is reviewed every year. | Companies that emit more than 3,000 tonnes of CO2 equivalent must report. ( Many companies voluntarily report even if they are not applicable.) | NA | NA | Based on GMP (total methane emissions have been reduced by about 35% from 1990) | YES |

NA = not available.

# Chapter 3

# Initiatives and Frameworks of Methane Emissions Management

Methane emissions management has become a key issue for countries, industrial organisations, and companies worldwide. Various initiatives and frameworks have been launched globally and regionally. The following subchapters overview the main initiatives and frameworks, including their objectives, contents, guidelines, and memberships. In addition, global trends, desired directions, and current issues that can be identified from the study results are summarised.

## 1. Government-to-Government Level Initiatives for Methane Emissions Management

(i) Global Methane Pledge (GMP)[18]

In September 2021, the US Whitehouse announced a plan for the GMP at the Major Economies Forum on Energy and Climate to reduce global methane emissions collectively by at least 30% below 2020 levels by 2030. Also, in September 2021, the second QUAD (Japan–US–Australia–India) summit meeting was held in the US, at which Japan announced its participation in the GMP. Also, in November 2021, at COP26 hosted by the United Kingdom, 103 countries, in addition to the US and the EU, launched the GMP to reduce global methane emissions. Furthermore, by the time of COP27 hosted by Egypt in November 2022, the number of countries participating in the GMP had expanded to more than 150.

In June 2022, the US, the EU, and 11 countries (including Japan) announced the launch of the Global Methane Pledge Energy Pathway (GMPEP) to advance both climate change action and energy security. The initiative's reductions in flaring and methane emissions in the oil and gas sector should be cost-effective and help address climate change, improve air quality, and contribute to global gas supplies.

In November 2022, the United Nations (UN) and IMEO also announced a new satellite system for methane emissions detection, MARS (Methane Alert and Response System). The purpose of the system will be to corroborate the methane emissions reported by companies scientifically and to measure and monitor changes over time. The initiative is being built within the framework of GMPEP with initial funding from the European Commission, the government of the US, the Global Methane Hub, and the Bezos Earth Fund.

(ii) Global Methane Initiative (GMI)[19]

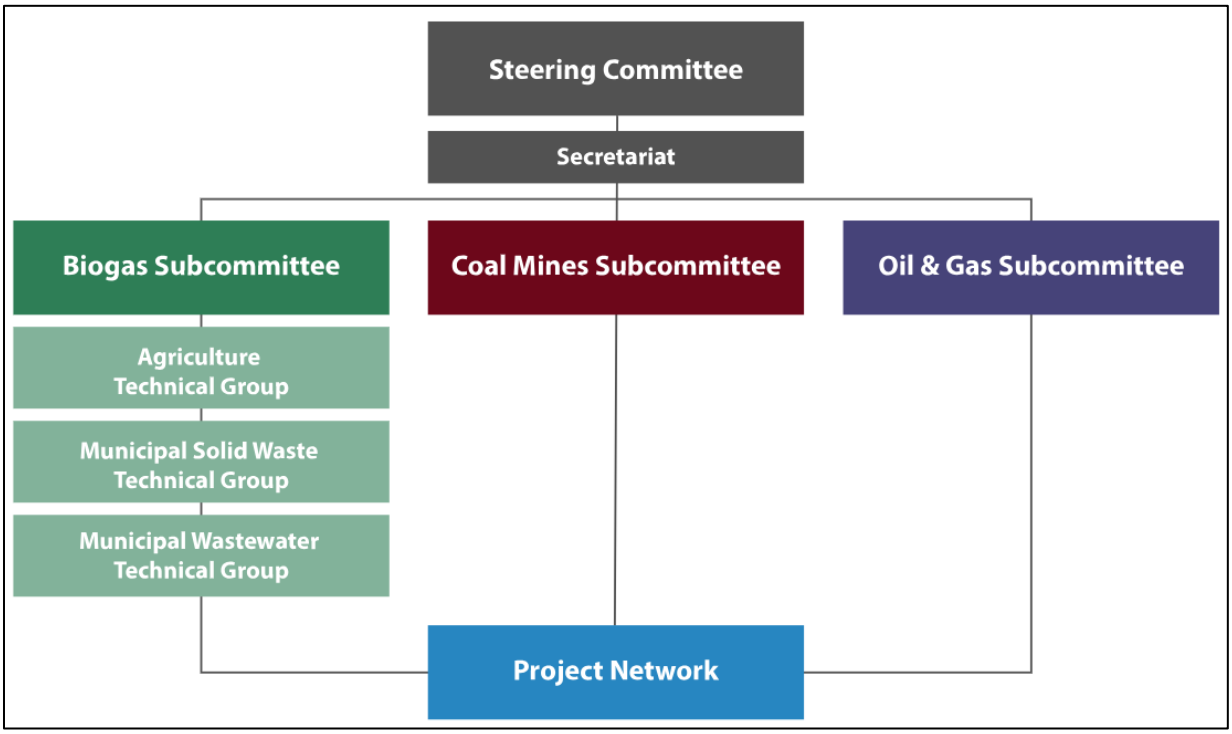
The Global Methane Initiative (GMI) was launched in 2004. It is an international public–private initiative that advances cost-effective, near-term methane abatement and recovery and use of methane as a valuable energy source in three sectors: biogas (including agriculture, municipal solid waste, and wastewater), coal mines, and oil and gas systems. As of July 2023, the 47 partnership countries include 4 ASEAN countries. The GMI collaborates routinely with other international organisations and initiatives, such as the UN Economic Commission for Europe and the Climate and Clean Air Coalition,

[18] GMP website, https://www.globalmethanepledge.org/

[19] GMI, 'About the Global Methane Initiative', https://www.globalmethane.org/about/index.aspx

to create synergies to mitigate methane globally.

**Figure 3.1. GMI Structure and Organisation**




Source: Global Methane Initiative website , https://www.globalmethane.org/about/index.aspx

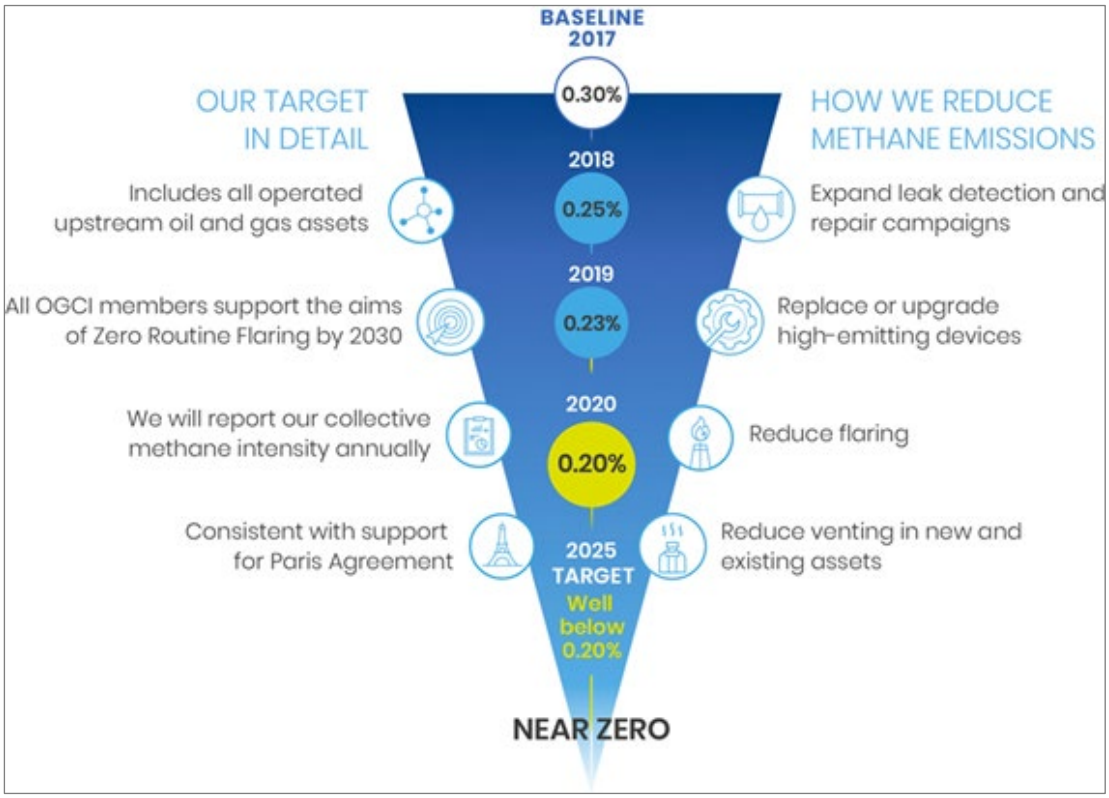
The GMI consists of a Steering Committee, three technical subcommittees, the Project Network, and the Secretariat that work together to promote project development and encourage active engagement from the private sector. The Steering Committee, which consists of representatives appointed by the partner countries, governs the Initiative's framework, policies and procedures. The Secretariat is hosted by the U.S. Environmental Protection Agency (EPA) as of July 2023. The Technical Subcommittees are organised by the main sources of methane emissions. Each subcommittee has developed a Subcommittee Action Plan that identifies the needs, opportunities and priorities for project development globally as well as key barriers and strategies to address them. The technical subcommittees also facilitate investment and financing opportunities and other cooperative activities and projects to advance the abatement and recovery of methane and its use as an energy source. The Project Network consists of representatives from industry, the research community, financial institutions, state and local governments and other expert stakeholders with an interest in developing and supporting methane abatement, recovery, and use projects in Partner Countries. Project Network members share their technical expertise, experience, and financial resources and are encouraged to attend subcommittee meetings and participate in developing sector-specific Action Plans. They also participate in specific activities such as capacity building, technology transfer, and outreach.

## 2. Company Initiatives for Methane Emissions Management

(i) Oil and Gas Climate Initiative (OGCI)[20]

The concept of the OGCI, a voluntary initiative by the upstream sector of the oil and gas industry to accelerate cooperative coordination on climate change into meaningful action, was announced at the World Economic Forum (Davos) in January 2014 and launched at the UN Climate Change Summit in September 2014. The OGCI is comprised of 12 member companies, including oil majors and state-owned companies such as bp, Chevron, and Shell, which together account for about 30% of global oil and gas production.

**Figure 3.2. OGCI Targets for Methane Intensity Reduction**




Source: OGCI.

OGCI's target is to reduce average methane intensity in the oil and gas industry (upstream sector) from a baseline of 0.30 % in 2017 to a level below 0.20 % by 2025. In November 2016, OGCI also established OGCI Climate Investments, a fund that will invest $1 billion over the next 10 years. It aims to accelerate the global implementation of low-carbon solutions in the energy, industrial, building, and commercial transportation sectors, investing in 31 technologies and projects (10 methane emission reductions, 12 CO2 reductions, and 9 CO2 recycling projects) as of March 2023.

In addition, OGCI announced in July 2020 its commitment to join Global Gas Flaring Reduction Partnership and the Payne Institute for Public Policy (PIPP) at the Colorado School of Mines in providing approximately $1 million in financial and technical assistance. The project develops an online platform, 'Global Gas Flaring Explorer' featuring mapping and visualisation of gas flaring data at oil production

[20] OGCI website, https://www.ogci.com/

sites around the world. It is expected to improve monitoring and demonstration in the Zero Routine Flaring by 2030 Initiative, which was proposed by the World Bank in 2015 and aims to end routine flaring by 2030. Subsequently, in June 2022, each country announced a contribution of $4 million ($1.5 million for the US, $1.5 million for Germany, and about $1 million for Norway) to support the Global Gas Flaring Reduction Partnership.

(ii) Aiming for Zero Methane Emissions Initiative[21]

In March 2022, OGCI announced the launch of the Aiming for Zero Methane Emissions Initiative, an industry-led effort to achieve near zero methane emissions from its own operated oil and gas assets by 2030. In June 2022, QatarEnergy announced its participation in the Initiative, becoming the first company outside of the initial 12 signatories to join, followed by Wintershall DEA, Neptune Energy and Australia's Woodside Energy later in the year. In February 2023, JGC Holdings became the first Japanese company to announce its participation, and as of March 2023, more than 40 companies have joined the Initiative.

(iii) API (American Petroleum Institute) [22]

The API, the standard-setting organisation for the U.S. oil and natural gas sector, was established in 1919. The API has developed five complementary API-related standard guidelines for 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.

(iv) The Environmental Partnership[23]

The Environmental Partnership is comprised of companies in the U.S. oil and natural gas industry committed to continuously improving the industry's environmental performance. A group of 26 oil and natural gas production companies formed The Environmental Partnership in December 2017. The Partnership provides six environmental performance programs that oil and natural gas production, processing and transmission companies can implement within their operations. The program includes (i) Leak Detection and Repair, (ii) Pneumatic Controller, (iii) Manual Liquids Unloading, (iv) Compressor, (v) Pipeline Blowdown and (vi) Flare Management. The membership 102 companies improve their action by joining these programs and using the information data from EPA's Greenhouse Gas Reporting Program.

(v) Marcogaz[24]

The Marcogaz was established in 1968 as a representative body of the European gas industry. The Assessment of methane emissions for gas Transmission and Distribution system operators was published in October 2019 as a Marcogaz-related standards guideline. In addition, the MARCOGAZ methane emissions reporting template was published and submitted to the European Committee for Standardization (CEN) in August 2020 to develop a standard for methane emissions quantification. In addition, the Guidance for the MARCOGAZ methane emissions reporting template was published in October 2020 and the template has been adopted for reporting in the OGMP 2.0.

(vi) OGMP (Oil and Gas Methane Partnership)

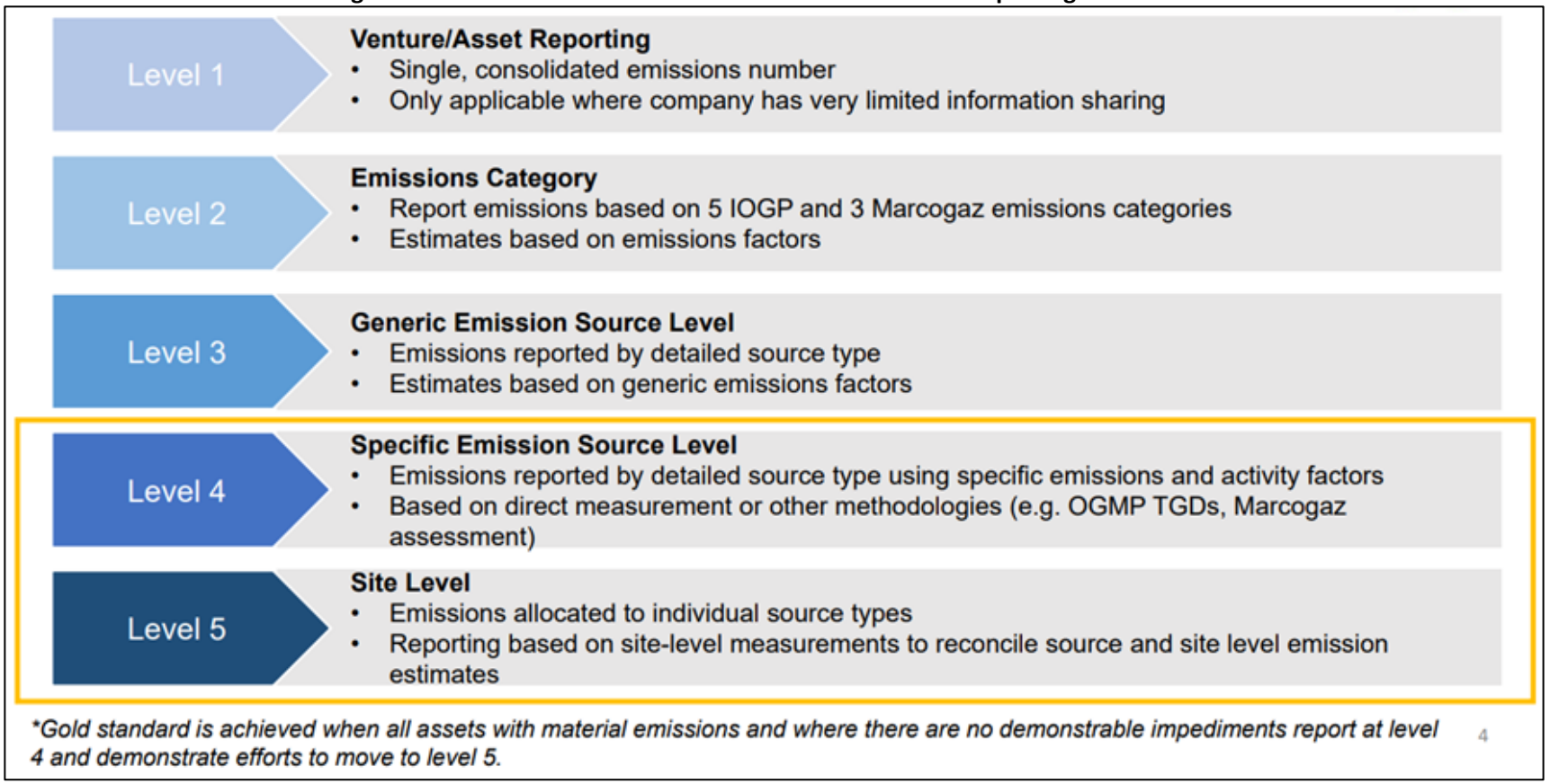
In November 2020, the OGMP announced OGMP 2.0, a new framework for MRV of methane emissions.

[21] Aiming for Zero website, https://aimingforzero.ogci.com/about/
[22] API website, https://www.api.org
[23] The Environmental Partnership website, https://theenvironmentalpartnership.org/
[24] Marcogaz website, https://www.marcogaz.org

Its predecessor, OGMP 1.0, was established at the 2014 UN Climate Summit as a voluntary framework for methane measures in the oil and gas industry. UNEP, the European Commission (EC), the Environmental Defense Fund, and the Climate And Clean Air Coalition established the latest OGGMP2.0 framework. The number of partner companies has increased from six at the beginning of the original OGMP in 2014 to 107 as of June 2023.

The OGMP2.0 emissions measurement and reporting is classified into five levels. Of these, Levels 1–3 require quantification using emission factors, while Levels 4–5 require quantification using direct measurements. In particular, the latter (Levels 4–5) is called the 'Gold Standard'. Level 4 requires bottom-up type measurements. such as on-site measurements, while Level 5 requires top-down type direct measurements, such as drones and satellites. In addition, participating companies must commit to the initiatives as a condition of membership, not as an absolute requirement to achieve them by the deadline.

**Figure 3.3. Five Levels of $CH_4$ Emissions Measurement and Reporting in OGMP2.0**




Source: UNEP., https://unece.org/sites/default/files/2021-04/Mr%20Mark%20Radka.%20Oil%20and%20Gas%20Methane%20Partnership%202.0%20and%20the%20International%20Methane%20Emissions%20Observatory.pdf

Furthermore, reporting data will be published only by sector and source, not on an individual asset basis. Only methane is covered; other GHGs, such as CO2, are not. In addition, only Scope 1 emission sources are covered; Scope 2 and 3 are not covered. A Global Warming Potential (GWP) of 72x–85x is recommended for CO2-based emissions calculations. The OGMP2.0 Technical Guidance Documents (TGDs) have been published, which provide specific methodologies for Levels 3 and 4 for major emission sources. However, member companies may adopt a different methodology, in which case proof of equivalence to the TGDs is required.

In March 2021, UNEP, in cooperation with the EC, announced the creation of the International Methane Emissions Observatory (IMEO) as a supervising body for OGMP 2.0 reporting. IMEO's role is to collect data from companies through reporting to the OGMP, improve the accuracy of emissions estimates, and publish an annual report on the status of methane emissions. In October 2021, the launch of the observatory was reported at the G20 Summit, and the first OGMP 2.0/IMEO annual report, the IMEO 2021 Report[25], was published. In this report, 64 of the 74 member companies (12 upstream, 33 midstream, and 19 downstream) submitted reports. In October 2022, the IMEO 2022 Report[26] was released with 13 new member companies (10 upstream, 3 midstream/downstream), and 36% upstream, 56% midstream, and 10% downstream achieved Level 4 (Gold Standard) reporting, an improvement from the previous year.

(vii) NGSI (Natural Gas Sustainability Initiative)

The Natural Gas Sustainability Initiative (NGSI) was launched by the American Gas Association and Edison Electric Institute, together with the investor community and experts from upstream, midstream, and downstream natural gas companies. The NGSI is an overarching framework to recognise and advance innovative, voluntary programs across the natural gas supply chain. The NGSI framework is initially focused on methane emissions. The NGSI Methane Emissions Intensity Protocol[27], Version 1.0, was publicly announced in February 2021. Version 1.0 includes five data reporting templates, one for each of the following segments of the natural gas value chain – production, gathering and boosting, processing, transmission and storage, and distribution. The EEI and American Gas Association members are more than 200 companies. They can disclose the resulting methane emissions intensity on their company-specific sustainability webpage.

(viii) International Group of Liquefied Natural Gas Importers (GIIGNL) MRV and GHG Neutral LNG Framework[28]

The GIIGNL was established in 1971 as an industry association for LNG importers. In November 2021, the GIIGNL MRV and GHG Neutral LNG Framework, which incorporates all GHG emissions associated with cargo, was released. The guidelines define four categories of CNL common terms: (i) GHG footprint, (ii) GHG Offset, (iii) GHG Offset with Reduction Plan, and (iv) GHG Neutral, and recommend measurement of GHG amounts for each cargo. As a recent development, Shell announced in January

[25] UNEP (2021), 'An Eye on Methane: International Methane Emissions Observatory 2021 Report', 31 October, https://www.unep.org/resources/report/eye-methane-international-methane-emissions-observatory-2021-report

[26] UNEP (2022), 'An Eye on Methane: International Methane Emissions Observatory 2022 Report, Nairobi, https://wedocs.unep.org/bitstream/handle/20.500.11822/40864/eye_on_methane.pdf

[27] AGA (n.d.), 'Natural Gas Sustainability Initiative (NGSI), https://www.aga.org/research-policy/natural-gas-esg-sustainability/natural-gas-sustainability-initiative-ngsi/

[28] GIIGNL (2021), 'GIIGNL releases MRV and GHG Neutral Framework', 17 November, https://giignl.org/giignl-releases-framework-for-transparent-emissions-reporting-and-neutrality-declarations/

2023 that it had delivered LNG from Gorgon LNG (Australia) to CPC (Taiwan) for the first time in accordance with the framework.

(ix) Veritas[29]

Veritas is a methane emission measurement and verification initiative led by GTI Energy. Veritas' technical protocols will provide companies and countries with methane emissions reduction targets with a consistent approach to measuring and verifying methane emissions- enabling a credible, consistent, verifiable, and transparent methodology. The Veritas technical protocols[30] cover six segments of the natural gas supply chain, ranging from upstream to downstream (production, gathering and boosting, processing, transmission and storage, distribution, and LNG). These technology-neutral protocols formulate a comprehensive toolbox of technologies designed to accurately measure total emissions. GTI Energy has solicited input from a diverse group of stakeholders to ensure the methodology is widely accepted and adopted. Stakeholders include academics, environmental non-governmental organisations, companies, investors, policymakers, and vendors. More than 35 companies partnered with Veritas to shape the protocols' development.

(x) MiQ[31]

The MiQ was established in December 2020 by the US RMI[32] and the UK SYSTEMIQ as a third-party auditing organisation for methane. It has developed its framework, the MiQ Standard, as a rulebook for conducting assessments related to methane emissions management. The MiQ Standard provides an A-F grading system for reportable facilities based on the degree of achievement of three criteria: Methane Intensity, Company Practices, and Monitoring Technology Deployment. Recent trends include using a new rating system for facilities scheduled to be completed by 2023. As a recent development, in January 2023, MiQ announced that it had monitored and rated 17% of US gas production in 1 year, and that 10 companies, including bp, ExxonMobil, and Chesapeake Energy, had obtained certification.

[29] Veritas website, https://veritas.gti.energy/

[30] Veritas (n.d.), 'Protocols', https://veritas.gti.energy/protocols

[31] MIQ website, https://miqregistry.org/

[32] RMI says that it is an independent, non-partisan, nonprofit organization of experts across disciplines working to accelerate the clean energy transition and improve lives. https://rmi.org/about/

## 3. Summary of Methane Emissions Management Initiatives and Framework

The initiatives and frameworks for methane emissions management described in this report are categorised as shown in Figure 3.4. There are several general initiatives, including declarations of national-level efforts, setting reduction targets, and initiatives that implement specific methane emission reduction measures. Amongst them are frameworks that have guidelines for measuring and reporting methane emissions. In this report, third-party certification organisations are also categorised as one of the frameworks with guidelines.

**Figure 3.4. Categorisation of Initiatives and Frameworks for Methane Emissions Management**


Source: Website of each initiative and framework for methane emissions management.

Table 3.1 summarises the initiatives and frameworks described in this report. More than 150 countries are participating in the GMP, a national-level initiative, and momentum for methane emission reduction is growing around the world. At the corporate level, there is progress in launching and participating in frameworks, particularly by the major energy companies in the upstream sector. In addition, midstream and downstream natural gas companies are also making industry-wide efforts, including the development of guidelines for measurement, and reporting by industry associations. In the ASEAN region, six countries are participating in the GMP and GMI, but only a few are currently participating in other corporate-level initiatives. Since different regions, producers, and consumers of natural gas participate in the same initiatives and frameworks, it is expected to spread geographically and over the entire natural gas supply chain.

Since many methane emissions management frameworks have been established in a brief period, there are a variety of guidelines for measuring and reporting methane emissions. It is difficult to compare emissions between frameworks and to calculate emissions for the entire supply chain. Therefore, standardisation and coordination of guidelines are an issue to be addressed in the future. To widely adopt the guidelines, it is necessary to consider a balanced approach that includes the needs of various businesses and the ease of operation in the field.

**Table 3.1. Methane Emissions Management Initiatives and Frameworks**

| Initiative and Framework | Numerical Targets | Activity | Guideline | Number of Memberships* | |
|---|---|---|---|---|---|
| | | | | Total | ASEAN |
| GMP | Global methane emissions collectively by at least 30% below 2020 levels by 2030 | • Hold annual ministerial meetings to review the progress<br>• Launch 'pathways' of policies and initiatives to promote methane reduction | N/A | >150 | 6 |
| GMI | N/A | • Cooperate with other initiatives<br>• Develop an action plan<br>• Promote investment and other cooperative activities<br>• Share technical expertise and financial resources | GMI Tools (Bio-sector only) | 47 | 4 |
| OGCI | Methane intensity to a level below 0.20% by 2025 | • Sharing best practices<br>• Methane leak detection and removal<br>• 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.<br>• Report methane emissions annually<br>• Continuous improvement of Measurement, Reporting, and Verification (MRV) | NA | 40 | 0 |
| API | N/A | • Innovative facility design<br>• Improved operational methods and procedures | Compendium of Greenhouse Gas Emissions | >500 | 0 |

| | | | | | |
|---|---|---|---|---|---|
| | | • Advances in emissions detection and measurement<br>• Improved accuracy of emissions reporting data | Methodologies | | |
| 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<br>• Developing and monitoring technology solutions to detect, quantify, report, and mitigate CH4 emissions | Assessment of methane emissions for gas transmission and distribution systems | 29 | 0 |
| OGMP2.0 | N/A | • Updating guidance on methane emissions management<br>• Regular operational meetings and technical workshops | OGMP2.0 Technical Guidance Document | 107 | 1 |
| 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 | • Rating and independent audit certification of gas with respect to methane emissions | The MIQ Standard | 10 | 0 |

Note: *GMP and GMI memberships indicate the number of countries; others indicate the number of companies.
N/A = not applicable.
Source: Website of each initiative and framework for methane emissions management

## 4. A New Initiative Announced at the LNG Producer–Consumer Conference 2023 – CLEAN

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 an initiative, the Coalition for LNG Emission Abatement toward Net-zero (CLEAN)'', to reduce methane emissions. The launch of CLEAN was announced at the LNG Producer–Consumer Conference held on the same day. At the conference, the governments of Australia, the EC, Japan, the Republic of Korea, and the US signed a joint statement emphasising the importance of CLEAN for GHG reduction, particularly methane, throughout the LNG value chain.

CLEAN is an initiative where LNG consumers work with LNG producers to reduce methane emissions in the LNG value chain. With the support of the governments of Japan, the Republic of Korea, the US, and JOGMEC, the initiative is expected to improve the visibility of methane emissions through dialogue with LNG producers and to expand and disseminate best practices for reducing methane emissions. JOGMEC will support the initiative by providing an information platform on methane reduction targets and measures.

The initiative is significant as it has been initiated jointly by two of the largest LNG importers in the world for the first time in the history of the LNG industry to openly ask for more transparent information on GHG profiles of the LNG they import from all their LNG suppliers. The initiative's success depends on the wider participation of the industry players and details of how the initiative is implemented in practice. The initiative is also expected to support efforts to standardise MRVs in gas and LNG production.

**Figure 3.5. Joint Statement at the LNG Producer–Consumer Conference**


Source: Ministry of Economy, Trade and Industry, https://www.meti.go.jp/english/press/2023/0719_002.html.

# Chapter 4

# Individual Corporate Initiatives on Methane Emissions Management

This chapter summarises the main initiatives and frameworks to which companies worldwide are members, their methane emissions and emission reduction targets, and describes each company's approach to methane emissions management.

## 1. General Initiatives

### 1.1. Membership in Initiatives and Frameworks

Table 4.1 shows examples of major initiatives and frameworks to which selected companies worldwide are members. Although European companies tend to be members of more initiatives and frameworks than their Asian counterparts, each company is a member of some Initiative or framework and measures, reports, and certifies its activities.

**Table 4.1. Major Initiatives and Frameworks with which Selected Companies Worldwide Are Affiliated**

| Company | Initiative and Framework |
|---|---|
| bp | OGCI, OGMP2.0, etc. |
| Shell | OGCI, OGMP2.0, etc. |
| TotalEnergies | OGCI, OGMP2.0, etc. |
| Enagás | OGMP2.0, GIIGNL, etc. |
| INPEX | GIIGNL (Associate Members), etc. |
| JAPEX | GIIGNL (Associate Members), etc. |
| Tokyo Gas | GIIGNL, etc. |
| Petronas | OGMP2.0, etc. |
| Pavilion Energy | GIIGNL, etc. |
| PTT | GIIGNL, etc. |
| Pertamina | GIIGNL (Associate Members), etc. |

Source: Compiled from company data.

### 1.2. Setting of Emission Reduction Targets

Table 4.2 shows the methane emission reduction targets of selected companies worldwide. The type of targets varies from company to company, but they are publicly announced. European companies have either one or both goals of reducing methane emissions and the intensity of methane emissions. On the other hand, many Asian companies have only GHG emission reduction targets.

Shell and bp have targets to reduce their methane emission intensity to a level below 0.20% by 2025,

which is the target of the OGCI, of which they are members. Bp's target is based on a new measurement methodology that it aims to implement across its related operations by the end of 2023.

**Table 4.2. Methane Emission Reduction Targets for Selected Companies Worldwide**

| Company | Methane Reduction Target |
|---|---|
| bp | Methane emission intensity below 0.2% by 2025 |
| Shell | Methane emission intensity below 0.2% by 2025 |
| TotalEnergies | 1. Maintain the methane emission intensity of commercial gas produced at gas facilities below 0.1<br>2. Reduce methane emissions by 50% between 2020 and 2025 and 80% between 2020 and 2030 |
| Enagás | Reduce methane emissions by 45% by 2025 and 60% by 2030 compared to 2015 |
| INPEX | Maintain methane emission intensity at the current low level (about 0.1%) |
| JAPEX | GHG emissions reduction targets only |
| Tokyo Gas | GHG emissions reduction targets only |
| Petronas | 1) Reduce methane emissions from the entire PETRONAS Group natural gas value chain by 50% by 2025<br>2) Reduce methane emissions from the entire PETRONAS Group natural gas value chain by 70% by 2030<br>3) Reduce methane emissions from Malaysia's natural gas value chain by 50% by 2030 |
| Pavilion Energy | GHG emissions reduction targets only |
| PTT | GHG emissions reduction targets only |
| Pertamina | GHG emissions reduction targets only |

Source: Compiled from company data.

## 2. Measurement, Reporting, and Verification (MRV)

### 2.1. Disclosures of Methane Emissions

In recent years, many companies have begun to disclose their emissions due to the growing importance of methane emissions management worldwide. In addition, some companies have subdivided their emissions reporting items and are now publishing emissions by factor and gas type, as well as by domestic and overseas emissions. However, since the calculation method of methane emissions differs from company to company, standardisation and coordination of calculation methods and improvement of transparency are required in the future.

**Table 4.3. Global Methane Emissions of Selected Companies**

| Company | Methane Emissions (tonnes) | CH4 intensity (%) |
|---|---|---|
| bp | 30,000 (2022) | 0.05 (2022) |
| Shell | 40,000 (2022) | 0.05 (2022) |
| TotalEnergies | 42,000 (2022) | 0.11 (2022) |
| Enagás | 2,413 (2022) | - |
| INPEX | 4,880 (2021) | 0.05 (2022) |
| JAPEX | 1,119 (FY2021) | - |
| Tokyo Gas | 290 (FY2021) | - |
| Petronas | 215,400 (2021) | - |
| Pavilion Energy | Only GHG emissions are published | - |
| PTT | 43,469 (2022) | - |
| Pertamina | 83,000 (2022) | - |

Source: Compiled from company data.

### 2.2. Certification

(i) ExxonMobil

In September 2021, ExxonMobil announced that its Poker Lake facility in the Permian Basin, New Mexico, had received the highest-grade A from MiQ for methane emissions control in natural gas production. In April 2022, the Permian Basin facility's 200 million cubic feet/day of natural gas production received the highest-grade A from MiQ, making it the first company to receive certification for petroleum-associated natural gas production.

(ii) bp

In March 2023, bp's US and onshore natural gas producer, bpx Energy, announced that it had obtained MiQ certification for all onshore facilities it operates in Texas and Louisiana in that country.

### 2.3. LNG with Methane Emissions Certification

(i) QatarEnergy, Pavilion Energy, Chevron

In April 2020, Singapore's Pavilion Energy solicited LNG deliveries of up to 2 million tonnes per year for 5 years beginning in 2023 and requested cooperation from suppliers in establishing and implementing GHG measurement and reporting methods for emissions from the wellhead to the unloading terminal. Subsequently, in November 2020, Qatar Petroleum (now QatarEnergy) signed a deal with Pavilion Energy, the first long-term LNG deal to include environmental conditions aimed at reducing the carbon footprint of the LNG supply. Then, in November 2021, Pavilion Energy, QatarEnergy, and Chevron announced that they had issued a quantification and reporting methodology for preparing a Statement of GHG Emissions (SGE) for LNG cargoes. The SGE Methodology complements GIIGNL's MRV and GHG Neutral Framework efforts.

(ii) Cheniere Energy

Cheniere Energy of the US announced the release of an LNG life cycle analysis that will improve how it assesses GHG emissions in August 2021. The analysis utilises GHG emissions data specific to Cheniere's LNG supply chain and will serve as the basic analysis tool for GHG emissions estimates included in Cheniere's Cargo Emissions Tags (CE Tags). In April 2022, Cheniere also announced that it would collaborate with natural gas midstream companies, methane detection technology providers, and university research departments, including the Colorado State University, to quantify, monitor, report, and verify (QMRV) GHG emissions in its LNG supply chain. The QMRV implementation will use surface, mid-air, and drone emissions monitoring technologies. Additionally, in October 2022, Cheniere announced its participation in OGMP 2.0. The company also announced the start of issuing CE Tags to buyers with estimated GHG emissions for each cargo it produces.

## 3. Initiatives on Methane Emissions Management

### 3.1. Flare Reduction

(i) Petronas

Petronas announced its support for the World Bank's Zero Routine Flaring by 2030 Initiative in November 2021. Under this initiative, Petronas pledged to avoid steady-state flaring in new oil field development and eliminate steady-state flaring in existing oil production sites by 2030. With this pledge, Petronas joins a global coalition of stakeholders demonstrating strong environmental leadership by publicly reporting flaring data annually. The first disclosure is scheduled for 2023. In 2021, the company reduced methane by 0.38 million tonnes through its flaring and off-gassing reduction efforts.[33]

(ii) JAPEX

JAPEX flares as much as possible to reduce vent emissions during normal operations. Low-pressure excess gas generated during crude oil production is not flared and is effectively used as fuel for in-house consumption. Monthly flare emissions are compiled and analysed in-house by site and month. The analysis results are fed back to each site to determine any abnormalities in flare volumes and to consider reduction measures.

### 3.2. LDAR

(i) Shell

In 2020, the company announced that it would use drones to enhance methane leak detection and repair (LDAR) at more than 400 sites in the Permian Basin in the US.

(ii) INPEX

INPEX conducted survey and identification work on methane deviation from facilities and equipment in domestic projects in FY2019 and established a system for tabulation and reporting methane deviation. In FY2020, laser methane detectors were introduced, and inspections were conducted at almost all target locations; where deviations were identified, countermeasures were immediately taken. In FY2022, the LDAR programme using infrared cameras was implemented at the Central Processing

[33] PETRONAS (2023), 'PETRONAS' Pathway to Net Zero Carbon Emissions 2050', https://www.petronas.com/sites/default/files/download/pdf/PETRONAS%20Pathway%20to%20NZCE%202050%20Third%20Edition%20Apr%202023.pdf

Facility and Floating Production Storage and Offloading of the Ichthys LNG project to inspect for methane deviation. Similar efforts are being considered for other overseas projects.[34]

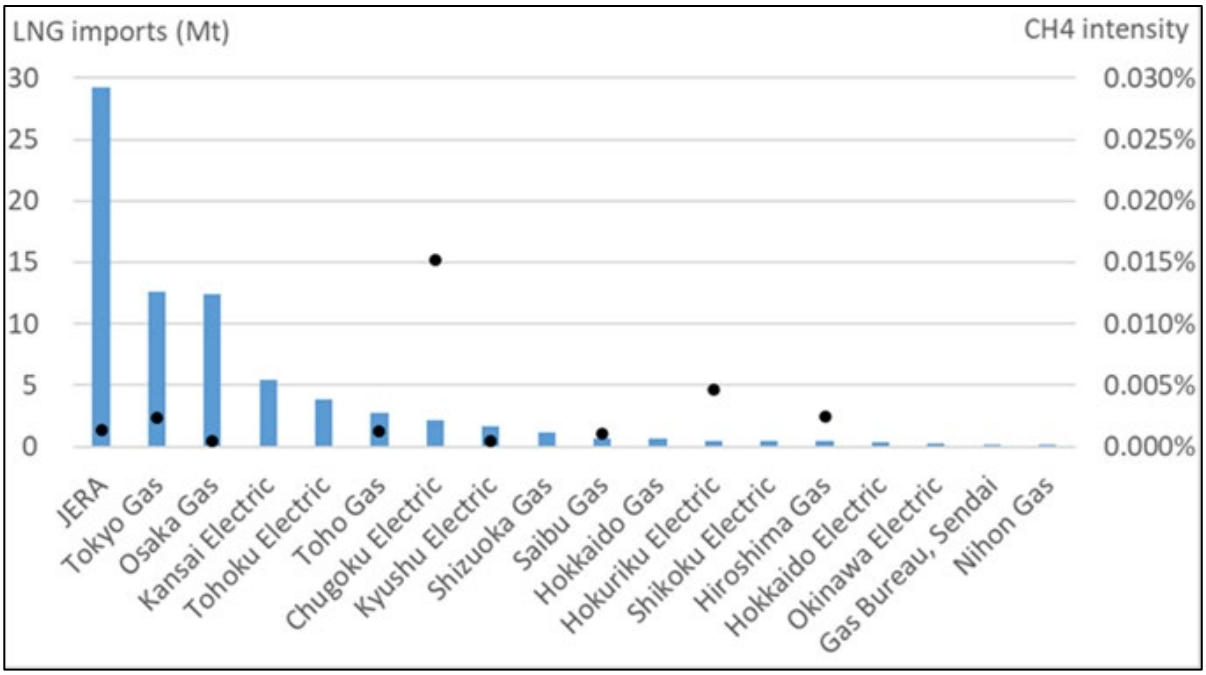
(iii) JAPEX

JAPEX regularly conducts methane leak detection in pipelines and production sites and implements countermeasures when leaks are detected. Leakage inspections are conducted once a year, but for valves and other high-risk leakage points, inspections are conducted once every 3 months. Management standards have also been established for buried piping at production sites, and in principle, leak inspections using gas detectors are conducted at least once every 3 months. In addition, gas detectors are installed in the buildings of production sites to monitor the amount of leakage at all times.

(iv) Japanese Companies

Japanese companies have been working on leak detection for many years from a security perspective (similar to the LDAR concept, but the LDAR name is rarely used). In calculating the methane emission intensity of Japanese companies, the values are mostly controlled at low levels, less than 0.005% (Figure 4.1). This indicates that leakage control, which Japanese companies have cultivated in the past on the back of safety measures, has been thoroughly implemented. For example, Spanish downstream operator Nedgia, awarded Level 4 for two consecutive years amongst OGMP2.0 participants, has relatively large methane emissions of 2,140 tonnes in 2021 and an emission intensity target of 0.022% by 2025.

**Figure 4.1. Japan LNG Imports and Methane Emission Intensity by Country (2021)**




Note: $CH_4$ intensity: (Min) (Emissions from onshore and offshore gas production) divided by total gas production, (Max) (Emissions from [Gas production + PL/LNG facilities]) divided by total gas production
Sources: Compiled from data included in each company's sustainability report.

[34] INPEX (2022), 'Sustainability Report 2022', https://www.sustainability-report.inpex.co.jp/fy2022/jp/climate-change/climate-change-goals.html

### 3.3. CCUS (vent avoidance)

(i) A consortium of companies, including Mitsubishi Corporation

A consortium of companies, including Mitsubishi Corporation, is a partner in the Tangguh LNG project in Papua Barat, Indonesia. The year 2021 saw the Vorwata Carbon Capture and Storage (CCUS) project announcement at the Tangguh LNG project. The Vorwata CCUS development will inject approximately 25 million tonnes of $CO_2$ into the Vorwata reservoir and increase gas production through enhanced gas recovery. This $CO_2$ injection will avoid venting and reduce $CO_2$ emissions by up to 90% of those currently associated with natural gas production at Tangguh LNG, and about half of the project's total emissions.[35]

## 4. Technology and Operational Expertise for Methane Emissions Management

### 4.1. Measurement Technology Development and Operational Improvement

(i) Chevron

In 2022, Chevron contracted GHGSat to monitor up to 22 oil and gas production facilities worldwide using GHGSat's high-resolution satellite technology. GHGSat has the satellite technology and data analysis capabilities to monitor, detect, and quantify methane emissions from onshore industrial sources. The collaboration between the two companies will continue with onshore methane monitoring projects and offshore pilots.[36]

(ii) TotalEnergies

In May 2022, the company announced it would begin drone-mounted emissions detection and surveying at its upstream oil and gas operations. This will be done using the Aerial Emission Survey Equipment for Environmental Action technology developed with CNRS (France) and the University of Reims Champagne Ardenne, which is a small, combined sensor mounted on a drone that can detect $CH_4$ and $CO_2$ and identify the source of emissions at the same time.

(iii) bp

In March 2023, bp's US and onshore natural gas producer, bpx Energy, announced that it had obtained MiQ certification for all onshore facilities it operates in Texas and Louisiana. This investment supports bp's Aim 4: to install methane measurements at all existing major oil and gas processing facilities by 2023 and achieve a 50% reduction in methane intensity across its operations.[37]

[35] Mitsubishi (2022), 'Indonesia Tangguh LNG Project Extension of Production Sharing Agreement (PSC)', press release, https://www.mitsubishicorp.com/jp/en/pr/archive/2022/html/0000050300.html.

[36] GHG Sat (2022), 'Chevron Takes Action on Methane', blog, 26 October, https://www.ghgsat.com/en/newsroom/chevron-takes-action-on-methane/

[37] bp (2022), 'bp Ventures Makes £3 Million Cash Injection in Unmanned Aviation and Methane Tech Firm Flylogix', 22 March, https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/news-and-insights/press-releases/bp-ventures-makes-3-million-cash-injection-in-unmanned-aviation-and-methane-tech-firm-flylogix.pdf

(iv) JGC Holdings Corporation

In September 2022, JGC Holdings Corporation announced [38] that JGC Global had signed a memorandum of understanding (MoU) with PT Panca Amara Utama (PAU), an Indonesian ammonia production and sales company that includes Mitsubishi Corporation as a shareholder, to conduct GHG emission measurement, including methane. Before this, in March 2021, JOGMEC and Mitsubishi Corporation agreed with PAU to conduct a joint study on carbon capture and storage and CO2 utilisation for ammonia production, and an MoU was signed between the four parties, including Bandung Institute of Technology in Indonesia. Based on the concluded MoU, the CI value of the product was calculated by calculating GHG emissions per tonne of ammonia at PAU's production site from November to December 2022. This was the first measurement case where the guidelines were applied as part of a JOGMEC project.

(v) JGC Holdings Corporation

In March 2023, JGC Holdings Corporation announced[39] that it had constructed a facility for evaluating methane emission measurement techniques at its research and development center (Oarai, Ibaraki), designed to measure methane emissions from oil and natural gas–related facilities. The facility will provide domestic and overseas manufacturers with measuring instruments and other equipment with a place to evaluate their detection capabilities and develop technologies for methane emission measurement technology, which is still in its infancy worldwide, to improve measurement technology capabilities through broad collaboration.

In mid-February of the same year, with JOGMEC's support, five domestic and foreign companies with detection technology were invited to the facility to conduct tests on methane emission measurement technology. specifically, in addition to Konica Minolta and ANA, SeekOps from the US and The Sniffers and Aeromon from Europe conducted a technical evaluation of the methane measurement technology possessed by each company.[40]

[38] JGC Holdings Corporation (2022), 'Signing of Memorandum of Understanding regarding GHG Emissions Measurement at Ammonia Production Plant in Indonesia', 26 September, https://www.jgc.com/en/news/2022/20220926.html

[39] JGC Holdings Corporation (2023), 'Methane Measurement Evaluation Facility also Constructed', 7 March, https://www.jgc.com/en/news/2023/20230307_2.html

[40] JGC (2023), 'Japan Joins First Global Initiative to Achieve Zero Methane Emissions', news release, 7 March, https://www.jgc.com/en/news/2023/20230307_2.html.

**Figure 4.2. Appearance of Methane Emission Measurement Technology Evaluation Facility**

Source: JGC Holdings website, https://www.jgc.com/en/news/2023/20230307_2.html

(vi) JOGMEC

JOGMEC announced that it signed a contract with All Nippon Airways (ANA) to conduct a consignment study on the measurement of GHGs using aircraft and drones in November 2022. The Japan Aerospace Exploration Agency, which has been working with ANA on verifying and validating the technology, will also cooperate in this project. Through this joint research, the three companies aim to implement the top-down method in society, which is expected to be used as a verification method for reported GHG emissions.

(vii) INPEX Corporation

In December 2022, INPEX Corporation, INPEX Pipeline, Mitsubishi Heavy Industries, and Mitsubishi Heavy Industries Machinery Technology, Ltd. conducted a demonstration test of CoasTitan®, an autonomous unstaffed networked surveillance system of Mitsubishi Heavy Industries, near a gas pipeline line in Kashiwazaki, Niigata, which is owned by INPEX and maintained by its wholly owned subsidiary, INPEX Pipeline. The test confirmed the safety of long-distance autonomous drone flights using long-term evolution or LTE communication, a mobile terminal communication standard. It confirmed road conditions and transmitted images in real- time using artificial intelligence. The results confirmed the feasibility of pipeline patrols by autonomous uncrewed vehicles.[41]

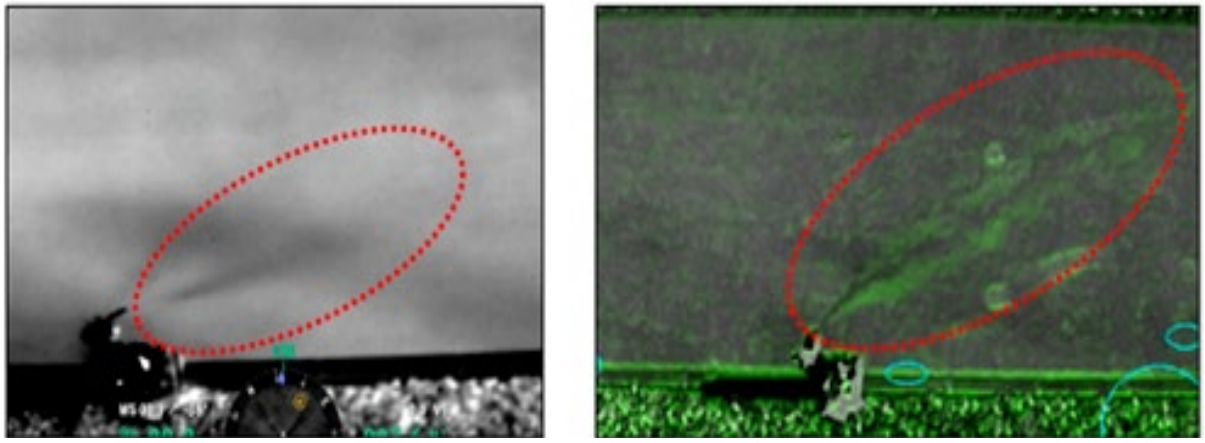
In April 2023, INPEX Corporation and INPEX Pipeline, in collaboration with IRS Systems (IRS), announced that they had conducted a methane gas detection demonstration test under simulated leak conditions using the OGI640[42] drone-mounted gas detection camera provided by IRS, and obtained valuable

[41] INPEX Corporation (2022), 'Drone Flight Demonstration Test Conducted Using LTE Communications Trial in Niigata Prefecture, Japan aimed to prevent natural gas pipeline accidents by automating patrols using uncrewed autonomous vehicles with CoasTitan®', 22 December, https://www.inpex.co.jp/english/news/assets/pdf/20221222.pdf

[42] LikedALL website, 'OGI 640', https://linkedall.com/products/ogi-640

results. The results of the test were as follows.[43]

**Figure 4.2. Methane Gas Imaging Data by 'OGI640'**



Note: Left photo: Methane gas photographed by 'OGI640'; right photo: Gas enhanced by image processing.
Source: INPEX Corporation, https://www.inpex.co.jp/news/2023/20230427.html

(viii) PETRONAS

PETRONAS continues to explore the optimal top-down methane measurement via various MoUs to assess emerging technologies. Amongst the technologies tested in 2022 were satellites and drones to measure methane emissions from onshore and nearshore facilities. Based on the evaluations, suitable top-down measurement technology will be selected to enable reconciliation with bottom-up measurement and meet OGMP2.0 Gold Standard expectations.[44]

### 4.2. Development of Methane Emission Reduction Technology and Operational Improvement

(i) INPEX

INPEX Corporation has studied flare reduction measures in cooperation with relevant internal departments since FY2021. As part of the research and development of flare reduction measures, INPEX is looking into the introduction of initiatives in Japan to reduce CO2 emissions into the atmosphere by applying methane cracking technology to fix the carbon content in flare gas.[45]

(ii) JAPEX

JAPEX is studying and implementing new measures for gas-enhanced recovery technology, in which CO2 separated and recovered from the natural gas produced at Scope 1 is injected underground.

[43] INPEX Group (2023), 'INPEX Conducts Successful Drone-based Gas Detection Test', 27 April, https://www.inpex.co.jp/english/news/assets/pdf/20230427.pdf
[44] PETRONAS (2022), '2022 Integrated Report: Resolutely Progressive', https://www.petronas.com/sites/default/files/uploads/content/2023/PETRONAS-Integrated-Report-2022_0.pdf
[45] INPEX (2022), 'Sustainability Report 2022', https://www.inpex.co.jp/english/csr/pdf/INPEX_SustainabilityReport2022_Eng.pdf

### 4.3. Sharing of Expertise

(i) Chevron

In February 2023, Chevron New Ventures and Egypt's Ministry of Petroleum and Mineral Resources announced they signed an MoU to share best practices and expertise in methane emissions reduction.

(ii) PETRONAS, PERTAMINA, PTT

The ASEAN Energy Sector Methane Roundtable was established in October 2021 to promote cooperation on methane emissions management in the oil and gas sector in the ASEAN region. The roundtable is held semi-annually with the participation of major ASEAN oil and gas companies such as Malaysia's PETRONAS, Thailand's PTT, and Indonesia's PERTAMINA, as well as international organisations such as the IEA, World Bank, and UNEP. It promotes methane emissions management in the ASEAN region through information sharing, technology exchange, and open dialogue.

Petronas launched the ASEAN Energy Sector Methane Leadership Program in June 2023 in collaboration with ASEAN energy companies, government agencies, and international organisations. They announced a methane reduction flagship project in partnership with JOGMEC. The project includes a methane quantification study, feasible solutions to achieve zero flaring daily, and potential future cooperation on an electrification hub.[46]

**Figure 4.3. Launch of the Energy Sector Methane Leadership Program**


Source: Petronas, https://www.petronas.com/media/media-releases/petronas-collaborates-partners-accelerate-methane-emissions-reduction.

(iii) Asia Natural Gas Energy Association (ANGEA)

ANGEA was the inaugural sponsor of the Innovative Technologies to Identify and Measure Oil and Gas Sector Methane Emissions in Southeast Asia[47] on 7–8 December 2022. It was the first sponsor of the

[46] PETRONAS (2023), 'PETRONAS Collaborates with Partners to Accelerate Methane Emissions Reduction', 27 June, https://www.petronas.com/media/media-releases/petronas-collaborates-partners-accelerate-methane-emissions-reduction

[47] ASEAN Centre for Energy, 'Statement: Innovative Technologies to Identify and Measure Oil & Gas Sector Methane Emissions in Southeast Asia', https://aseanenergy.org/innovative-technologies-to-identify-and-measure-oil-gas-sector-methane-emissions-in-southeast-asia/

conference. The regional Southeast Asia USAID workshop was jointly developed with the USAID Smart Power Program in collaboration with the ASEAN Centre for Energy. In addition to sponsorship support, ANGEA provided subject matter expertise, bringing industry best practices to the region's policymakers and industry peers. ANGEA members collaborate to develop tools and materials to enable industry advances and build regulations.

## 5. Other Initiatives

### 5.1. Research on biomethane

(i) PERTAMINA

In April 2022, PERTAMINA, Osaka Gas, INPEX Corporation, and JGC Holdings Corporation signed an agreement for joint research on utilising biomethane derived from palm oil mill effluent (POME) in Indonesia. POME produces a large amount of methane, which is released into the atmosphere, and the two parties aim to utilise this methane as biomethane. In March 2023, JGC Holdings Corporation and NUS signed a memorandum of understanding with Gas Malaysia Bhd to conduct a 'Joint Study for Sustainable Development of Palm Oil Industry' in Malaysia.

## 6. Summary of Individual Corporate Initiatives

Methane emissions management has been increasingly considered as one of the corporate social responsibilities. On the other hand, the reduction targets and emissions figures announced by companies need to be standardised and made more transparent. For the moment, the scope of management and calculation methods are different for each company. As for ASEAN companies, some of them have announced GHG reduction targets and emissions. However, only a few of them have exclusively set targets and emissions for methane. For effective methane emissions management, it is desirable to set specific methane targets and initiatives.

Amongst natural gas and LNG sellers, some companies are adding third-party certification of methane emissions management or emissions certification for their products. With growing societal interest and increasing engagement by companies in methane emissions management, products with certified appropriate emissions management and lower emissions can differentiate them from competitors and strengthen the company's competitiveness.

Flare reduction, which Petronas and others have done with great success, should be considered a high-priority emission reduction measure. LDAR is another basic methane emission management measure implemented worldwide, although it is a relatively new term. The very low methane emission intensity of Japanese companies indicates the effectiveness of LDAR. Additionally, it indicates that Japanese companies' expertise can be one of the ways to accelerate methane emission management in ASEAN.

The development and implementation of methane emission management technologies by various companies would lead to more accurate measurement and cost-effective reduction technologies in the future. To achieve faster and more effective methane emission management, it is also important to promote adopting the technology after the development phase. In parallel with technology development, it is also necessary to share the latest expertise, technologies, and practices and raise companies' interest in them.

Collaboration with advanced companies and amongst companies in the same region and industry (including membership in initiatives and frameworks) can accelerate methane emission initiatives by

sharing best practices, etc. There are already advanced companies In the ASEAN region, such as Petronas, Pavilion Energy, and others. Initiatives such as the ASEAN Energy Sector Methane Roundtable and the ASEAN Energy Sector Methane Leadership Program have also been launched to promote collaboration across ASEAN companies, and these initiatives are expected to spread to the entire ASEAN region.

# Chapter 5

# Technologies for Methane Emissions Management

Methane emissions measurement and reduction technologies are key to advancing methane emissions management. Oil and natural gas industry stakeholders have developed, tested, and operated various technologies. This section summarises the main technologies for methane emission management, and their development and implementation status.

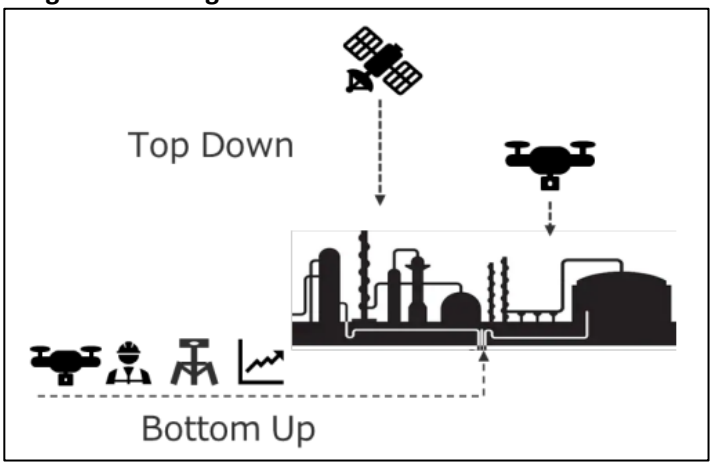
## 1. Measurement Technologies for Methane Emissions Management

Identifying the location and volume of emissions by applying measurement technologies to manage methane emissions is essential. Methane emissions measurement is fundamental for routine methane leakage monitoring and for considering reduction technologies, which are described later. Methane measurement technologies are classified into top-down and bottom-up types, as shown in Figure 5.1. Top-down measurements (e.g. satellites and drones) can provide comprehensive emissions data for a site or region, but obtaining data from individual sources is difficult. Generally, the lower measurable limits and uncertainties are higher than bottom-up measurements.

On the other hand, bottom-up measurements (e.g. gas sampling, optical gas imaging with an infrared camera) can measure emissions from individual emission sources. Lower measurable limits and uncertainties are relatively low, but emissions from unexpected sources may be highly likely to be missed. The CI guidelines[48] issued by JOGMEC provide the measurement image and applicable measurement methods for each methane emission source based on the characteristics of the measurement technologies, as shown in Figure 5.1 and Table 5.1. This part introduces the features, advantages, disadvantages, and application examples of measurement technologies.

[48] JOGMEC (2023), 'Recommended Guideline for Greenhouse Gas and Carbon Intensity Accounting Frameworks for LNG/Hydrogen/Ammonia Projects (JOGMEC CI Guideline), https://www.jogmec.go.jp/content/300384406.pdf

**Figure 5.1. Image of Methane Emissions Measurement**




Source: JOGMEC, Recommended Guideline for Greenhouse Gas and Carbon Intensity Accounting frameworks for LNG/Hydrogen/Ammonia Projects (JOGMEC CI Guideline), https://www.jogmec.go.jp/content/300384406.pdf

**Table 5.1. Methane Measurement Methods for Each Emission Source**

| Emission Source Classification | | Methane Measurement Method (*1) |
|---|---|---|
| Combustion | Stationary Combustion | Gas sampling, Infrared camera, Drone |
| Vent | Flare/Vent | Infrared camera, Drone |
| | Process vent | Infrared camera, Drone, High flow sampler |
| | Other flares and vents | Infrared camera, Drone, High flow sampler |
| Leak | Feedstock transportation and product manufacturing process | Infrared camera, High flow sampler |
| Over the facility subject to methane emission control | | Satellite, Drone |

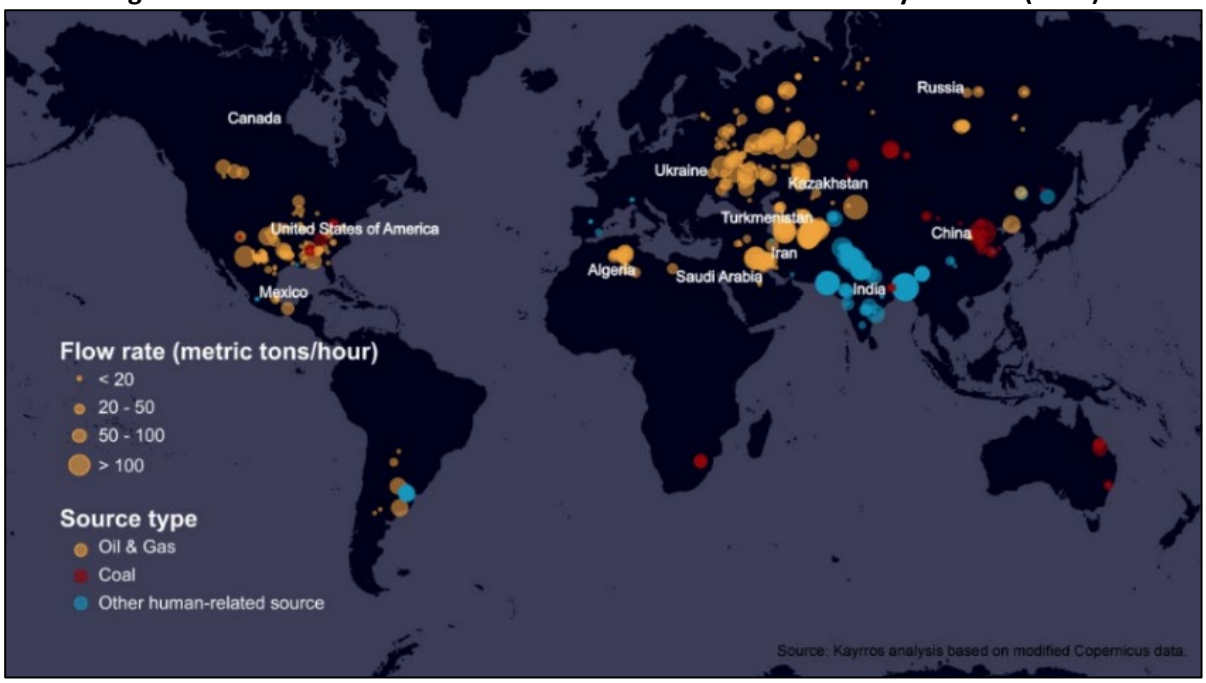
*1: This table is revised based on the results of technical verification.
Source: JOGMEC.

(i) Satellites (Top-Down)

Although wide-area observations of methane emissions by satellite have proven useful as technology has advanced, it is difficult to quantitatively estimate emissions at this time. One of the strengths of satellites is their ability to make measurements over a wide area, at high frequency, and over a long period. On the other hand, the weaknesses of satellites are that the detection limit is limited to large-scale leakage, detailed leakage cannot be measured, and offshore measurement is not possible due to the influence of weather conditions such as cloud cover and reflections from the sea surface.

Leading measurement companies include (i) GHGSat, a company specialising in monitoring satellite technology; (ii) Scepter, a general measurement company; and (iii) Kayrros, an environmental information company. In a recent development, Kayrros announced in January 2023 that it will collaborate with UNEP and provide its data to IMEO to make global data on methane emission sources available.

**Figure 5.2. Methane Emissions from Human Activities Detected by Satellite (2022)**



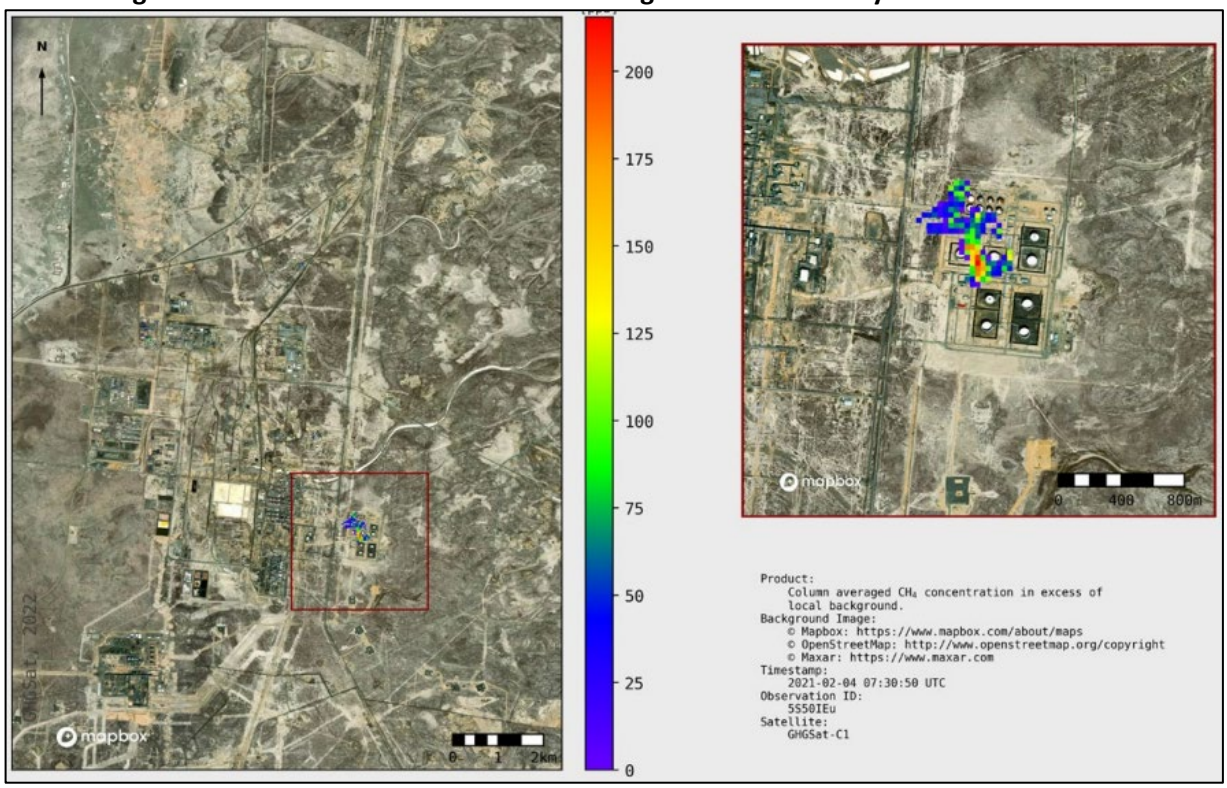

Source: Kayrros., https://www.iea.org/reports/global-methane-tracker-2022/overview

As a result of the satellite measurements, a paper on methane emissions, 'Chasing after Methane's Ultra-emitters', was published in the scientific journal Science in February 2022. The paper stated that over 1,200 methane emission events of 25 tonnes per hour or more detected by satellite in 2019–2020 were observed as ultra-emitters. However, these were not included in national GHG inventories. It also noted that most of these were in the six largest oil- and gas-producing countries (Algeria, Iran, Kaakhstan, Russia, Turkmenistan, and the US).

Natural gas companies have used satellite-based monitoring to manage emissions. Chevron and GHGSat conducted the pilot test[49] to confirm the satellite's capability at a location with a known emission source (a storage tank with emissions reduction efforts underway) with an estimated emissions rate near the lower end of the GHGSat satellite's detection threshold. As one of the results described in Figure 5.3, Satellite measurement detected the source and showed its capability. After the test, Chevron contracted GHGSat to monitor up to 22 onshore assets worldwide in 2022.

[49] Chevron (2022), '2022 Methane Report', https://www.chevron.com/-/media/shared-media/documents/chevron-methane-report.pdf

**Figure 5.3. Methane Emissions from a Storage Tank Detected by a GHGSat Satellite**

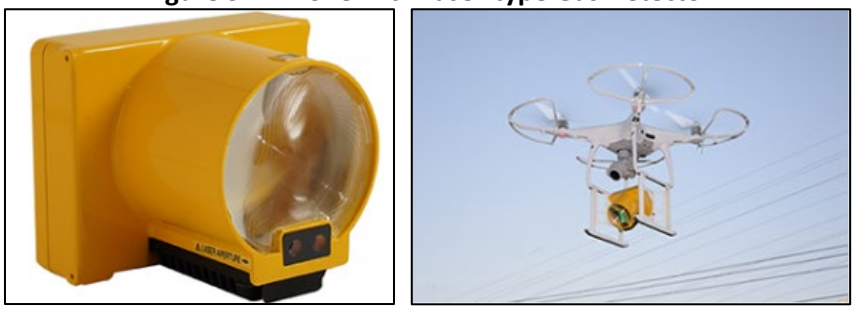



Source: Chevron, 2022 Methane Report, https://www.chevron.com/-/media/shared-media/documents/chevron-methane-report.pdf

(ii) Drone (Top-Down/Bottom-Up)

Drones are promising as a method that is less expensive than satellites, can be implemented at offshore plants, and are considered the most advanced in terms of cost-effectiveness. The strengths of drone measurement include area-level quantification, element-by-element leakage identification, measurement of inaccessible areas, and ease of setup. On the other hand, weaknesses include difficulty in quantifying each element, limited payload, and non-explosion proof. SeekOps is one of the leading measurement companies. Tokyo Gas uses a drone with a lightweight laser methane detector[50] to monitor leaks.

**Figure 5.4. Drone with Laser-type Gas Detector**



Source: Tokyo Gas Engineering Solutions Corporation website, https://www.tokyogas-es.co.jp/en/business/eq/laser_falcon.html.

[50] Tokyo Gas Engineering Solutions (n.d.), 'Methane Gas Detector "Laser Falcon"', https://www.tokyogas-es.co.jp/en/business/eq/laser_falcon.html.

(iii) Optical gas imaging (OGI) camera: (Bottom-Up)

OGI cameras are considered a more quantitative observation method than satellites or drones. Strengths of the measurement include continuous measurement and the ability to measure even trace amounts of leakage. Weaknesses include the limited area that can be measured with fixed sensors and the need for a power supply and cable installation. FLIR is one of the leading measurement companies.

**Figure 5.5. Optical Gas Imaging (OGI) Cameras for Hydrocarbons**

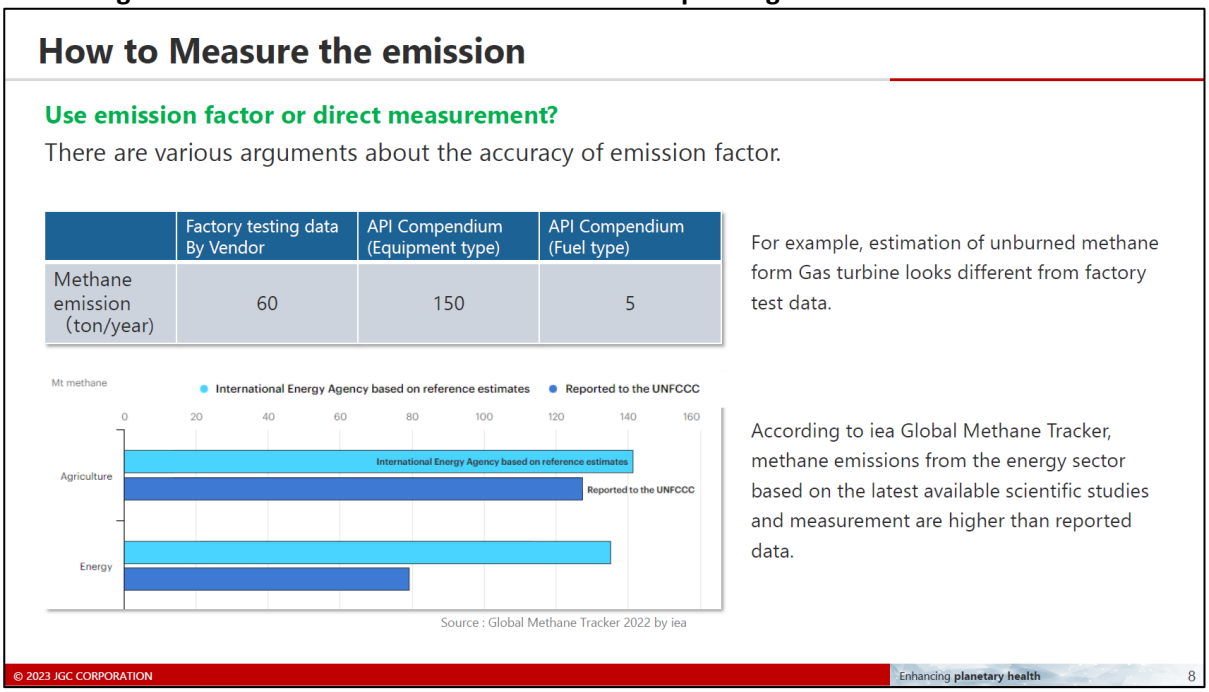
Source: Teledyne FLIR website, https://www.flir.com/products/flir-g-series/

(iv) Calculations using general emission factors

In many criteria and standards, the method of calculating GHG emissions uses secondary data that multiplies activity data, such as production, with a general emission factor instead of measuring methane emissions directly. The method using secondary data is simple, but when the calculated values are different from the actual operating conditions of the plant, concerns regarding the GHG emissions calculation presenting the actual state of the project arise. At the online workshop held on 28 June 2023, JGC Holdings gave examples of concerns about calculation methods using general emission factors. The upper table in Figure 5.6 estimates unburned methane emissions from gas turbines. In this example, the methane emissions are 150 tonnes/year for the API compendium equipment type but 5 tonnes/year for the API compendium fuel type.

On the other hand, the factory test data shows 60 tonnes/year. The emission results show a huge difference due to the different calculation methods. As another comparison, data from the IEA Global Methane Trackers is shown below in Figure X. According to the IEA Global Methane Tracker, methane emissions from the energy sector based on the latest available scientific studies and measurements are estimated to be higher than reported data. In other words, almost all national inventories are suspected of underreported emissions. Therefore, quantifying methane through direct measurement is an important first step in determining the actual emissions and verifying emission factors. To update and develop methane gas quantification technology, JGC Holdings built a facility at a laboratory in Japan to evaluate methane emission measurement technology. The company is evaluating the detection capability of methane emission measurement and developing the technology with domestic and international measurement equipment manufacturers.

**Figure 5.6. Differences in Methane Emissions Depending on the Calculation Method**



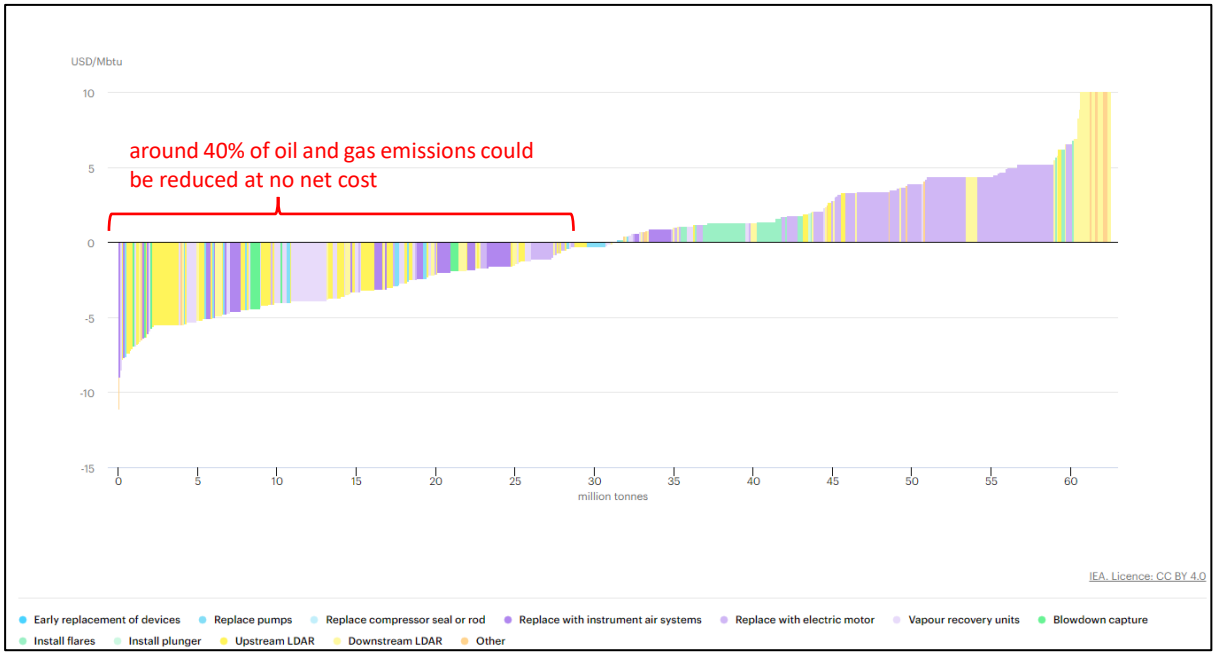

Source: Tomohide Muraoka, Chief Engineer, JGC Holdings, Page 8 of presentation material, 'JGC Group Initiatives for Methane management', at the ERIA Workshop on 'Effective Management of Methane Emission in ASEAN' on 28 June 2023.

## 2. Methane Emission Reduction Technologies

The methane emission reduction technologies to prevent methane emissions from oil and gas operations are well known and have been deployed in multiple locations worldwide. Many measures can also save money because the outlays required to deploy them are less than the market value of the methane that is captured and can be sold. According to the Global Methane Tracker 2023[51] published by the IEA, 'around 40% of oil and gas emissions could be reduced at no net cost using existing technologies' (Figure 5.7). IEA estimates it based on average natural gas prices from 2017 to 2021, the prevailing emissions sources, and capital and labour costs worldwide.

[51] IEA (n.d.), 'Strategies to Reduce Emissions from Oil and Gas Operations', https://www.iea.org/reports/global-methane-tracker-2023/strategies-to-reduce-emissions-from-oil-and-gas-operations

**Figure 5.7. Marginal Abatement Cost Curve for Oil and Gas Methane Emissions by Mitigation Measure (2022)**




Source: Global Methane Tracker 2023, IEA website, https://www.iea.org/reports/global-methane-tracker-2023/strategies-to-reduce-emissions-from-oil-and-gas-operations.

This part introduces an overview and key examples of each type of methane emission reduction measures, including replacement of equipment, installation of new equipment, leak detection, and repair. The type and cost-effectiveness of each measure are shown in Table 5.2.

**Table 5.2. Cost-effectiveness of Each Methane Emission Reduction Measure**

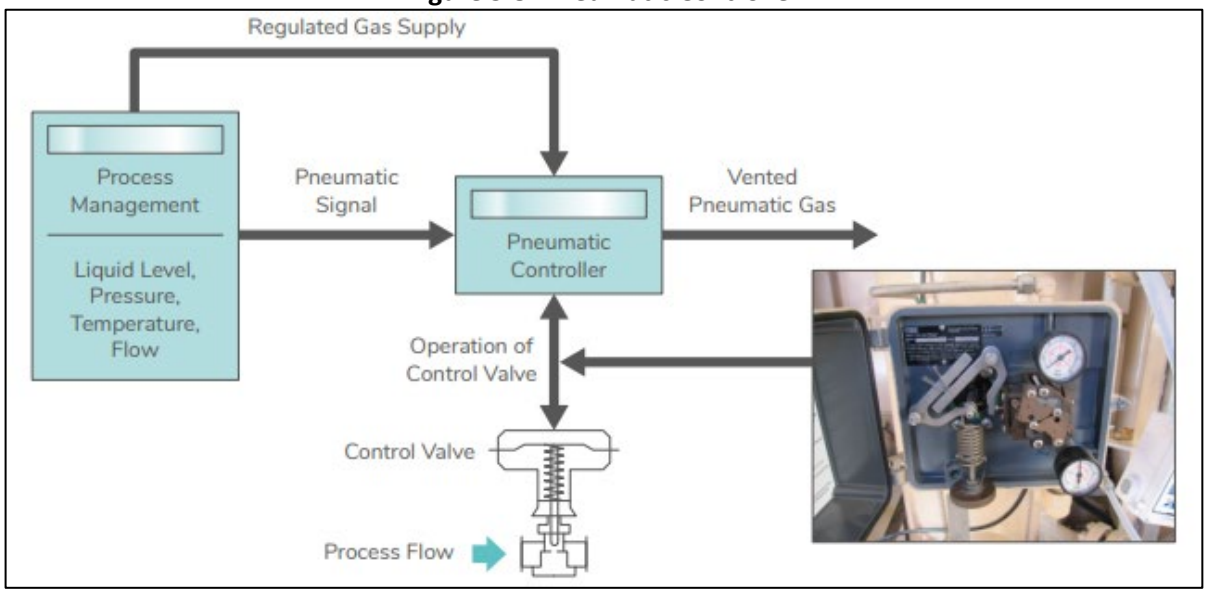
| Measure | Type | Cost-effectiveness |
|---|---|---|
| Replace pumps | Replacement | Large potential for implementation at zero net cost |
| Replace with instrument air systems | Replacement | Large potential for implementation at zero net cost |
| Replace with electric motor | Replacement | Installation and operation costs are likely to exceed the value of methane recovered |
| Vapour recovery unit | Installation | Large potential for implementation at zero net cost |
| Blowdown capture | Installation | Large potential for implementation at zero net cost |
| Install flares | Installation | Installation and operation costs directly incurred |
| Leak detection and repair in the Upstream sector | LDAR | Large potential for implementation at zero net cost |
| Leak detection and repair in the Downstream sector | LDAR | Compared to the Upstream sector, the potential for zero net cost implementation is limited. |

Notes: Replacement = replacement of equipment, Installation = installation of new equipment, LDAR = leak detection and repair.
Source: Global Methane Tracker 2023, IEA website, https://www.iea.org/reports/global-methane-tracker-2023/strategies-to-reduce-emissions-from-oil-and-gas-operations

## 2.1. Replacement of Equipment

Many equipment in the oil and natural gas value chains emit natural gas in their regular operation, including valves, gas-driven pneumatic controllers (Figure 5.8), and pumps. Replacing them with lower-emitting versions can reduce emissions.

**Figure 5.8. Pneumatic Controller**




Source: Methane Guiding Principles, https://methaneguidingprinciples.org/pdf/best-practice-guide/pneumatic-devices/Reducing-Methane-Emissions-Pneumatic-Devices-Guide.pdf.

(i) Replace pumps

Pneumatic pumps that use pressurised natural gas as a power source also vent natural gas in the ordinary course of their operation. These emissions can be eliminated through replacement with electrical pumps powered by solar or other generators or connected to the grid.

Operators are often required to dehydrate their produced natural gas saturated with water vapour to meet pipeline specifications. Water vapour in natural gas pipelines can form hydrates that can obstruct or plug the pipe. Also, water vapour in a pipeline can cause corrosion due to CO2 or hydrogen sulphide in natural gas. Most natural gas operators use glycol dehydrators to remove water from natural gas to meet pipeline water content requirements. At remote locations where electricity is not readily available, pressurised natural gas is often used to drive circulation pumps in glycol dehydration units. Circulation pumps in glycol dehydration units may run at hundreds of cubic meters of natural gas daily. These pumps can be replaced by standard electric pumps (if an electricity supply is available) or solar-powered pumps (if there is enough sunlight and a battery unit stores solar power for when there is no sunlight so that the pumps can run continuously). Figure 5.9 is an example of a replacement by the solar-powered pump.[52]

[52] Methane Guiding Principles, 'Reducing Methane Emissions: Best Practice Guide Pneumatic Devices', https://methaneguidingprinciples.org/pdf/best-practice-guide/pneumatic-devices/Reducing-Methane-Emissions-Pneumatic-Devices-Guide.pdf

**Figure 5.9. Solar Chemical Pump**

Source: Methane Guiding Principles, https://methaneguidingprinciples.org/pdf/best-practice-guide/pneumatic-devices/Reducing-Methane-Emissions-Pneumatic-Devices-Guide.pdf

(ii) Replace with instrument air systems

Instrument air systems can replace pumps and controllers that vent natural gas by design. Using compressed air rather than pressurised natural gas to drive pneumatic devices can eliminate methane emissions from venting. Due to the cost of compressed-air systems, they are mostly used at locations with a relatively high volume of pneumatic gases. Compressed-air systems typically consist of a compressor, a power source, a dehydrator, and a gas storage tank. Compressors switch on intermittently to maintain gas pressure in a storage tank. They are typically powered by electricity. At sites without electrical power, solar-powered air compressors can be used.

(iii) Replace with electric motor

Gas-driven pneumatic devices continuously release small amounts of gas, even when specified as 'low-bleed'. These devices can be replaced with 'zero-bleed' technologies that use electrical power, instead of pressurised natural gas. An electric motor can also replace a diesel or gas engine used onsite during drilling and well completion.

### 2.2. Installation of New Equipment

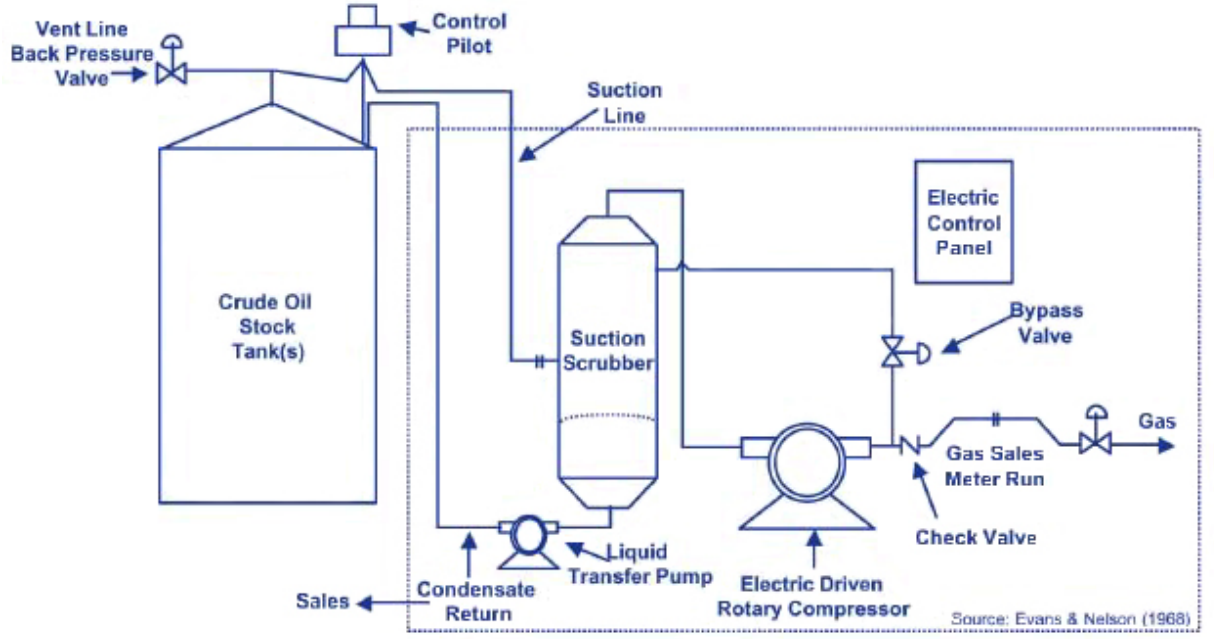
There are several opportunities across the supply chain to install new devices that can reduce or avoid large sources of methane emissions.

(i) Vapour Recovery Unit (VRU)

VRU consists of scrubbers and compressors designed to capture emissions that build up in pieces of

equipment across the oil and natural gas supply chains as Figure 5.10 is shown[53]. For instance, VRU can capture gases that accumulate in oil storage tanks and that are otherwise periodically vented to the atmosphere to prevent explosion.

**Figure 5.10. Standard Stock Tank Vapour Recovery System**




Source: The Natural Gas STAR Partners, https://www.unimaclp.com/wp-content/uploads/2021/09/Install-VRU-Storage-Tanks.pdf.

(ii) Blowdown capture

Gas blowdowns are conducted at wellheads or elsewhere along the supply chain when equipment (e.g. vessels, compressors) must be depressurised. Emergency signals or routine start-up or shutdown procedures can trigger blowdowns. When these happen, operators open up the well or equipment to remove the liquids and gas. Emissions are mitigated when excess gas is recovered, used onsite, or sent to the sales line instead of vented or flared.

Redesigning blowdown systems and altering emergency shutdown (ESD) are examples.[54] Modifying ESD vents and blowdown piping enables collection and re-routing of the gas to the sales line, the fuel box, lower pressure mains for non-emergency use (e.g. ESD testing), or flare systems. Designing isolation valves to minimise gas blowdown volumes is also a blowdown measure to reduce methane emissions.

(iii) Install properly functioning flaring capacity

While still a source of $CO_2$ and methane emissions, flaring is preferable to release methane gas into the atmosphere directly. Flares can be installed at oil and gas production sites where gas production exceeds onsite demand or nearby pipeline capacity to combust methane emissions. Portable flares can

[53] EPA (n.d.), 'Installing Vapor Recovery Units on Storage Tanks', https://www.unimaclp.com/wp-content/uploads/2021/09/Install-VRU-Storage-Tanks.pdf

[54] EPA, 'Redesign Blowdown Systems and Alter ESD Practices', *PRO Fact Sheet* No. 908, https://www.epa.gov/sites/default/files/2016-06/documents/redesignblowdownsystems.pdf

expand a facility's flare capacity and provide an outlet for gas captured during well workovers or completions. It is also noteworthy that incomplete combustion at flaring should be avoided to prevent undesirable release of remaining methane into the atmosphere.

### 2.3. Leak Detection and Repair (LDAR)

Leak detection and repair (LDAR) refers to locating and repairing fugitive leaks. LDAR encompasses several techniques and equipment types. One common approach is using infrared cameras, which make methane leaks visible. LDAR can be applied across the supply chain from upstream activities (including well development, gathering, and processing) to downstream activities (such as transmission or distribution lines).

## 3. Summary of Technologies

As described in the Measurement Technology Part, each measurement technology has pros and cons. It is important to select the most appropriate measurement technology based on the required accuracy, frequency of measurement, and site conditions. The guidelines issued by the US EPA, JOGMEC, other organisations, and case studies from other companies are useful references.

Advances in technology are expanding the range of direct measurement. Satellite measurements have revealed methane emissions not included in national GHG inventories. JGC Holdings has also indicated a discrepancy between direct measurement and calculated values through its measurement tests. It is essential to ensure transparency of emissions to promote methane emission management. Continuous efforts to improve the transparency of emissions are required by expanding direct measurements and updating emission factors.

The IEA Methane Tracker points out that many methane emission reduction measures can be implemented at zero net cost. Implementation of measures requires cost-effectiveness verification. Identifying methane emission locations and emissions with high accuracy will help provide a more reliable verification and early action. In addition to selecting appropriate measurement technologies, learning about precedent cases of other companies is effective.

Since many advanced companies are working on technological development related to methane emission control, applicable technologies are continually evolving. Even companies unable to develop technologies can advance their initiatives by learning about the latest trends in technology development and other companies' successful case studies.

# Chapter 6

# Recommendations

## 1. Key Recommendation 1: ASEAN should Positively Influence Global Methane Emissions Management and Ensure Energy Security at the Same Time.

As indicated by the IEA Methane Tracker, the methane emissions of ASEAN are the fourth-largest after China, the US, and India. Promoting methane emission management in the ASEAN region, rather than in a single country, could reduce global methane emissions and significantly impact the trend of methane emission management initiatives. The IEA Methane Tracker pointed out that 40% of methane emissions can be countered at zero net costs. The total methane emissions in the natural gas sector of the top three ASEAN countries (Indonesia, Thailand, and Malaysia) are 1 million tonnes per year. If all net cost zero measures were implemented, ASEAN could effectively utilise 0.4 million tonnes of natural gas annually (equivalent to 2%–3% of the region's LNG imports). Therefore, it is highly significant for the ASEAN energy security to tackle reducing methane emissions.

**Malaysia can play a leadership role in methane emissions management.**

It is fortunate for the ASEAN region that Malaysia, the largest producer and consumer of natural gas in the region, has low methane emissions. The most influential country in the natural gas sector in the ASEAN region is a progressive country in methane emissions management. This means that once Malaysia starts leading the initiative in methane emissions management, the movement can quickly spread to the ASEAN region. Malaysia can lead and involve other ASEAN countries in methane emissions management. It is important to involve individual companies in these initiatives.

**It should leverage ASEAN's advanced companies and attempts at inter-corporate collaboration.**

Around the world, companies are promoting methane emissions management on a group of multiple company basis. This includes the establishment of corporate alliances by upstream companies and the development of guidelines led by existing industry associations. In the ASEAN region, while national-level methane emissions management has made progress, including six countries' participation in the GMP and GMI, few companies have joined the initiative currently. In this regard, it should be noted that there are already advanced companies in the ASEAN region, such as PETRONAS and Pavilion Energy, and attempts at inter-corporate collaboration, such as roundtable meetings and the Methane Leadership Program. It is possible to spread the initiatives to the entire ASEAN companies by publicising the ASEAN's advanced companies and inter-company collaboration attempts.

## 2. Key Recommendation 2: Standardising and Harmonising Methane Emission Measurement Guidelines for Methane Emission Management and Improving Its Accuracy are Necessary.

The diversity of guidelines for measuring and reporting methane emissions makes it difficult to compare emissions between frameworks and calculate emissions for the entire supply chain. Therefore, standardisation and coordination of guidelines is a future challenge. Furthermore, although companies disclose their reduction targets and emissions to meet corporate social responsibility, targets and calculation methods differ from company to company. Hence, standardisation and ensuring

transparency are also issues to be addressed. These are major barriers to further progress in methane emissions management. And standardisation and normalisation of guidelines for measurement and reporting are desirable in the future. Recently, movements have been made to address this issue, mainly in Europe and the US. Some ASEAN stakeholders who can participate in this process should work to make the content operational in the ASEAN region.

The large difference between the IEA Methane Tracker and national government reports on methane emissions from the energy sector reveals the use of underestimated, or at least uncertain, emission factors and unknown sources of methane emissions in national government reports. This is an issue in understanding the actual methane emission situation. In addition, as pointed out in the JGC's measurement test, discrepancies between direct measurements and secondary data calculations can be large. To improve the accuracy of methane emission measurement, continued efforts to expand direct measurement and update emission factors are desirable in the ASEAN region.

## 3. Key Recommendation 3: The Expertise of Japanese Companies should be Leveraged to Accelerate Methane Emissions Management in ASEAN.

As a result of long-term methane leak detection efforts, the methane emission intensity of Japanese companies has been kept very low. In addition, JGC Holdings and JOGMEC are working on developing methane emission management technologies and guidelines and on the practical application of these technologies. It is effective to utilise the expertise of Japanese companies To accelerate methane emission control in ASEAN. ASEAN and Japanese companies should actively strengthen cooperation and conduct demonstration tests of the latest technologies in the ASEAN region.

## 4. Other Recommendations

**Recommendation 4: The first policy regarding methane emissions management is the development of measurement and reporting standards and mandatory reporting.**

While ASEAN countries have policies to reduce GHG emissions, few policies focus specifically on methane. It is effective to implement policies focused on methane emissions to promote methane emission reductions effectively. In addition, few companies have set methane-specific targets or announced their emissions. Companies should set targets and implement initiatives targeting methane emissions specifically.

For ASEAN policies on methane emission management, measurement and reporting standards should be developed, and reporting should be made mandatory to ensure fairness. Policies encouraging methane emission management, such as incentives and penalties, can be considered after measurement and reporting standards are developed. Suppose a company recognises that better management of methane emissions enhances its competitiveness and leads to larger sales of its natural gas supply. The company should easily make more efforts to measure and report more accurately and to reduce methane emissions.

**Recommendation 5: A low methane emission natural gas must be selected to eliminate methane emissions from the natural gas supply chain.**

The importance of natural gas is growing as natural gas consumption and LNG imports in ASEAN are expected to continue to increase. During the energy transition period, continued use of natural gas will be based on cleaner use of natural gas. In other words, methane emissions from the natural gas supply

chain must be eliminated. In addition to efforts to reduce methane emissions in one's own country, it is necessary to promote the reduction of methane emissions from the entire supply chain by selecting natural gas with lower methane emissions.

**Recommendation 6: Natural gas and LNG suppliers should strengthen their competitiveness through third-party certification and emissions verification.**

Public interest in methane emission reduction and efforts by companies to manage methane emissions are expected to grow. Products with certified appropriate emission management and low emissions help differentiate them from competitors and enhance a company's competitiveness.