

Trends in Methane Emission Management Across the LNG Value Chain

Satoshi Kihara*

1. Introduction

Oil and natural gas companies around the world are working to reduce greenhouse gas (GHG) emissions for a decarbonised society. While carbon dioxide (CO₂) has traditionally received great attention in GHG mitigation efforts, interest in methane (CH₄), a highly potent greenhouse gas, has grown rapidly in recent years. Methane is the second-largest contributor to global warming after CO₂. Its Global Warming Potential (GWP) is approximately 28 times larger than that of CO₂ over a 100-year period and approximately 80 times larger over a 20-year period. In addition, because methane has a relatively short atmospheric lifetime of approximately 12 years¹⁾, reducing methane emissions is considered a particularly effective means of mitigating climate change in the near term.

Among the sources of methane emissions, the energy sector, including oil, natural gas and coal, accounts for a significant share, and a large proportion of these emissions can be reduced using existing technologies. At the same time, discrepancies have been identified between emissions reported by individual countries and estimates based on direct measurements, including satellite observations. According to the International Energy Agency (IEA), estimates based on measured data indicate that methane emissions in many countries are substantially higher than officially reported levels²⁾. Such uncertainty in the accuracy of reported emissions makes it difficult to assess the effectiveness of methane mitigation measures, highlighting the need to strengthen Measurement, Reporting and Verification (MRV) systems.

Against this background, efforts to improve MRV of methane emissions across the entire liquefied natural gas (LNG) value chain are advancing globally, as LNG continues to attract attention as a relatively clean transition fuel. Policy frameworks are being developed through initiatives such as the Global Methane Pledge (GMP), which aims to reduce global methane emissions by 30% from 2020 levels by 2030; the European Union (EU) Methane Regulation, which extends methane-related requirements to imported fossil fuels; and, in Japan, one of the

world's largest LNG importing countries, the establishment of the Coalition for LNG Emission Abatement toward Net-zero (CLEAN), which promotes collaboration between LNG buyers and producers. Voluntary corporate initiatives are also expanding. Many international energy companies have joined the Oil & Gas Methane Partnership 2.0 (OGMP 2.0), led by the United Nations Environment Programme (UNEP), contributing to the advancement of methane emissions management and greater transparency.

The direction provided through these international frameworks is expected to encourage the development of methane mitigation policies by individual countries as well as concrete actions by companies. At the same time, challenges identified through corporate-level initiatives may provide important insights for the future review and development of international frameworks and national policies. This paper first examines the current state of methane emissions across the LNG value chain, before reviewing international frameworks, policy developments in major countries and regions, and corporate initiatives. It then considers the key challenges and future outlook for methane emissions management.

2. Methane Emissions across the LNG Value Chain

2.1 Stages of the LNG Value Chain and Sources of Methane Emissions

The LNG value chain can be broadly divided into three stages: upstream, midstream and downstream. The upstream stage encompasses gas field development and production, gas gathering and compression, and gas processing, covering the processes required prior to natural gas liquefaction. The midstream stage primarily consists of liquefaction, storage, loading and marine transportation, during which natural gas is converted into LNG and transported internationally. The downstream stage includes LNG receiving, regasification and gas supply, delivering natural gas to end-use markets.

Methane emissions occur at each of these stages through equipment leaks, venting, and incomplete combustion during flaring of excess gas. The mechanisms and volumes of methane emissions vary considerably depending on the equipment configuration and operating conditions at each stage. Nevertheless, the upstream stage is generally considered to

*Senior Researcher, Gas Group, Energy Security Unit
Institute of Energy Economics, Japan – IEEJ

10F, Inui Building Kachidoki
1-13-1 Kachidoki, Chuo-ku, Tokyo 104-0054, Japan

account for the largest share of methane emissions across the LNG value chain.

2.2 Methane Emissions Mitigation Measures

A large proportion of methane emissions across the LNG value chain can be reduced using existing technologies. According to the IEA, approximately 70% of the roughly 140 million tonnes of methane emitted from the fossil fuel sector in 2024 could be avoided by using existing technologies, while around 35 million tonnes could be reduced at no net cost³⁾.

Key mitigation measures include Leak Detection and Repair (LDAR), the replacement of high-emitting equipment with low-emission alternatives or electrification, the installation of Vapour Recovery Units (VRUs), and improvements in flaring practices. The deployment of emerging technologies, such as methane oxidation catalysts and microturbines, is also progressing.

As each mitigation technology differs in terms of its applicability, emissions reduction potential and cost, it is essential to select appropriate technologies according to facility scale and operating conditions. Going forward, reducing implementation costs and optimising the combination of multiple mitigation measures will be increasingly important.

2.3 Methane Emissions Measurement Technologies

Accurate quantification and verification of methane emissions are essential to ensure the effectiveness of emissions reduction efforts. Traditionally, emissions have mainly been estimated by using emission factors. However, discrepancies between reported and measured emissions have been identified, partly due to the highly dispersive nature of methane. Accordingly, there is growing demand for more accurate and transparent reporting based on measured data.

Methane emissions measurement technologies can be broadly classified into top-down and bottom-up measurements. Top-down measurements use satellites, aircraft, drones and other platforms to conduct large-scale observations from above, making them effective for assessing overall emissions and detecting abnormal emission events.

By contrast, bottom-up measurements involve detailed on-site measurements using technologies such as infrared cameras and gas analysers, enabling emission sources to be identified and quantified with a high degree of accuracy.

It is therefore important to establish an integrated MRV framework that combines top-down and bottom-up measurements. By integrating large-scale observations with on-site measurements, the accuracy and reliability of methane emissions quantification can be further improved.

3. International Frameworks

3.1 Development of International Frameworks for Methane Emissions Management

In recent years, methane emissions reduction has attracted increasing international attention as an effective measure for mitigating climate change in the near term. Against this background, governments, international organisations and companies have been developing a range of frameworks to address methane emissions. In addition to setting methane emissions reduction targets, these frameworks are expected to play important roles in strengthening MRV systems, improving data transparency, promoting voluntary emissions management by companies, and facilitating international cooperation.

This section reviews the main frameworks related to methane emissions management across the LNG value chain and provides an overview of their key features.

3.2 Global Methane Pledge (GMP)⁴⁾

The Global Methane Pledge (GMP) is an international initiative launched by the European Union (EU) and the United States at COP26 in 2021. As of 2025, 159 countries and the EU participate in the initiative. The GMP sets a collective goal of reducing global methane emissions by at least 30% from 2020 levels by 2030. Participating countries are also expected to improve methane emissions estimation methodologies and enhance the transparency of GHG reporting.

3.3 International Methane Emissions Observatory (IMEO)⁵⁾

The International Methane Emissions Observatory (IMEO) was established by the United Nations Environment Programme (UNEP) in 2021 with the aim of providing governments and companies with reliable methane emissions data. As a key initiative supporting the implementation of the Global Methane Pledge (GMP), IMEO conducts its activities around three pillars: Transparency, Science and Implementation.

More specifically, IMEO works to enhance transparency through initiatives such as the Oil & Gas Methane Partnership 2.0 (OGMP 2.0), which promotes the transition towards reporting based on measured data, and the Methane Alert and Response System (MARS), which uses satellite observations to detect large methane emission events. It also seeks to improve the accuracy of methane emissions estimates through international research and the development of emissions data. In addition, IMEO supports evidence-based policymaking by providing capacity-building assistance to governments and national oil companies.

3.4 Oil & Gas Methane Partnership 2.0 (OGMP 2.0)⁶⁾

The Oil & Gas Methane Partnership 2.0 (OGMP 2.0) is an international framework for oil and gas companies launched by UNEP and other organisations in November 2020. It aims to improve the measurement and reporting of methane emissions and enhance transparency. Participation has continued to expand, with 153 companies participating in the initiative as of 2025.

OGMP 2.0 places particular emphasis on reporting based on measured data and enables the progress of emissions reduction efforts to be compared across companies. Its reporting framework consists of five levels, from Level 1 to Level 5 (see Table 1). Levels 1 to 3 primarily involve reporting based on estimates using general emission factors, whereas Levels 4 and 5 require reporting based on measured data. Companies that achieve Level 4 or Level 5 reporting for all material assets are recognised as meeting the highest reporting standard, known as “the Gold Standard”. As a general rule, companies are expected to achieve this reporting standard within three years for operating assets and within five years for non-operating assets.

Table 1 OGMP 2.0 Measurement and Reporting Levels

Level	Measurement and Reporting Criteria
Level 1	● Report a single emissions figure without distinguishing between individual assets
Level 2	● Report emissions by source category (e.g. equipment, venting and flaring) ● Calculate emissions based on generic emission factors
Level 3	● Report emissions by individual emission source ● Calculate emissions based on generic emission factors
Level 4	● Report emissions by individual emission source ● Calculate emissions using source-specific emission factors derived from direct measurements or other methods
Level 5	● In addition to Level 4 reporting, conduct direct measurements at the site level to verify the Level 4 estimates

3.5 Coalition for LNG Emission Abatement toward Net-zero (CLEAN)⁷⁾

The Coalition for LNG Emission Abatement toward Net-zero (CLEAN) is an international public-private collaboration framework established in July 2023 with the support of Japan’s Ministry of Economy, Trade and Industry (METI) and the Japan Organization for Metals and Energy Security (JOGMEC). It aims to reduce methane emissions and improve transparency across the entire LNG value chain.

Under CLEAN, major LNG buyers, including JERA and Korea Gas Corporation (KOGAS), request LNG producers to provide information on methane emissions management and reduction

efforts, which is then compiled by JOGMEC. In addition, international collaboration on issues such as the development of certification systems and the use of satellite data is expanding through forums including the LNG Producer-Consumer Conference.

4. Policy Developments in Major Countries and Regions

4.1 Development of Methane Emissions Management Policies

Against the backdrop of the international frameworks discussed in the previous section, countries and regions have also been developing policies and regulatory frameworks aimed at reducing methane emissions. In particular, the Global Methane Pledge, which sets a collective emissions reduction target for 2030, has played an important role in encouraging countries to position methane emissions as a key policy issue. At the same time, the direction of policy responses varies depending on factors such as energy security considerations and government policy priorities, and policies may therefore be revised or, in some cases, rolled back.

This section reviews developments in methane emissions management policies in the United States, a major LNG exporting country; Europe, a major LNG importing region; and ASEAN, where LNG demand is expected to increase in the coming years.

4.2 Developments in the United States

In the United States, methane emissions regulations were strengthened under the Biden administration. At COP26 in 2021, the United States, together with the EU, played a leading role in launching the Global Methane Pledge. Furthermore, the Inflation Reduction Act (IRA), enacted in August 2022, established the Methane Emissions Reduction Program (MERP). Under the programme, measures were introduced, including the Waste Emissions Charge (WEC), financial and technical assistance, and revisions to Subpart W of the GHG Reporting Program.

By contrast, under the Trump administration, which took office in January 2025, efforts have been made to repeal the WEC and review existing reporting requirements. As a result, US methane emissions management policy has been moving towards deregulation.

4.3 Developments in Europe

In Europe, as part of the “Fit for 55” package, which aims to reduce GHG emissions by at least 55% from 1990 levels by 2030, the EU Methane Regulation (Regulation (EU) 2024/1787) on reducing methane emissions in the energy sector was formally adopted by the European Parliament and the Council in May 2024. The Regulation establishes a comprehensive framework covering

the upstream, midstream and downstream segments of the oil and natural gas sectors and represents the world's first regulation to address methane emissions associated with imported fossil fuels. The Regulation requires importers of fossil fuels into the EU to report methane emissions across the supply chain and, in the future, to demonstrate compliance with MRV requirements equivalent to those applicable to EU operators, as well as with methane intensity standards. Within the EU, operators are also required to implement Leak Detection and Repair (LDAR) programmes, while venting and flaring are prohibited in principle. While there are high expectations that the EU will take the lead in establishing global standards for methane emissions management as a global rule-maker, challenges have also been identified regarding the effectiveness and implementation of the Regulation. In particular, US LNG is supplied from a large number of geographically dispersed gas wells, making it technically and practically difficult to quantify emissions across the entire supply chain. Under the Biden administration, the United States sought recognition of its Methane Emissions Reduction Program (MERP) as equivalent to the EU Methane Regulation. Following the inauguration of the Trump administration, however, measures under MERP, including the Waste Emissions Charge (WEC) and financial support, have been rolled back, raising questions over the credibility of MERP.

Against this backdrop, it has been suggested that the EU may consider flexible and phased implementation of the Regulation, as well as simplification of reporting requirements, while seeking to balance regulatory objectives with the need to secure US LNG supplies as part of its efforts to reduce dependence on Russian energy.

4.4 Developments in ASEAN

The ASEAN region is attracting international attention as a key driver of future growth in LNG demand. Against this backdrop, ASEAN countries are advancing capacity-building initiatives and international cooperation aimed at reducing methane emissions.

In June 2023, the Methane Leadership Program (MLP) was launched, led by energy and environmental authorities from ASEAN member states together with national oil companies such as PETRONAS, Pertamina and PTT. The programme aims to strengthen methane emissions management capabilities in the oil and gas sector. In addition, JOGMEC and PETRONAS are examining measurement, monitoring, reporting and verification approaches suited to the policy and regulatory circumstances of the ASEAN region. Furthermore, through the establishment of the Southeast Asia Methane Emissions Technology Evaluation

Centre (Southeast Asia METEC), efforts are being made to strengthen MRV systems and facilitate the development of concrete methane emissions reduction projects.

5. Corporate Initiatives

5.1 Progress in Corporate Methane Emissions Management

Alongside the development of international frameworks and policy measures in major countries and regions, corporate efforts to manage methane emissions have also advanced. In addition to reducing methane emissions, companies are undertaking a wide range of measures, including improving measurement accuracy, enhancing data transparency and making use of third-party certification.

This section reviews corporate initiatives for methane emissions management across the LNG value chain. Through examples from major companies, it examines recent trends in efforts to quantify and reduce methane emissions and improve transparency.

5.2 CE Tags (Cheniere Energy)

Cheniere Energy, the largest LNG operator in the United States, began providing Cargo Emissions Tags (CE Tags) to customers under long-term LNG contracts in 2022. The initiative aims to support GHG emissions reductions by customers and suppliers by improving the transparency of GHG emissions across the entire supply chain and facilitating data sharing.

CE Tags are calculated using Cheniere's proprietary supplier-specific life-cycle assessment (LCA) model, which estimates GHG emissions across the entire LNG value chain, from the wellhead to the delivery point. The model is based on the calculation framework used in the LCA model developed by the National Energy Technology Laboratory (NETL) under the US Department of Energy (DOE). In addition to publicly available data for each stage of the value chain, the model incorporates operational data from Cheniere's Sabine Pass and Corpus Christi liquefaction facilities. Since launching CE Tags in 2022, Cheniere has issued more than 1,500 CE Tags as of 31 December 2024⁸⁾.

5.3 AUSEA (TotalEnergies)

TotalEnergies of France jointly developed the Airborne Ultralight Spectrometer for Environmental Applications (AUSEA) with the French National Centre for Scientific Research (CNRS) and the University of Reims Champagne-Ardenne, with the aim of enabling highly accurate measurement of methane emissions. AUSEA is an ultra-lightweight, drone-mounted CO₂ and CH₄ sensor capable of conducting high-precision measurements even at locations that are difficult to access using conventional bottom-up measurement methods.

AUSEA is used as an airborne measurement technology that complements both top-down and bottom-up approaches. Since 2022, TotalEnergies has progressively deployed the system across its own operating sites. The company also makes AUSEA available to other companies, contributing to methane emissions reduction across the wider industry through the sharing and deployment of the technology.

5.4 Use of Satellite Monitoring (Chevron / GHGSat)

Chevron entered into an agreement with Canada-based GHGSat in 2022 to monitor oil and gas production facilities using satellite technology. GHGSat's satellites are capable of detecting methane emissions as low as approximately 100 kg per hour and can identify emission sources with a spatial resolution of approximately 25 metres⁹⁾. Using this technology, Chevron monitors 22 onshore oil and gas production facilities around the world at least once a month, enabling the early detection of abnormal emissions, including super-emitters, and facilitating a more rapid on-site response and repair.

In addition, Chevron is participating with GHGSat, Shell and TotalEnergies in a demonstration project for satellite monitoring of offshore oil and gas production facilities, where satellite-based measurements are more challenging due to the reflection and scattering of sunlight from the sea surface.

5.5 Methane Emissions Measurement Technology Evaluation Facility (JGC Holdings)

In March 2023, JGC Holdings established a new Methane Emissions Measurement Technology Evaluation Facility at its technology research centre, designed to simulate methane emissions from oil and gas facilities. The facility provides domestic and international measurement equipment manufacturers with a venue for technology evaluation and development.

With support from JOGMEC, JGC Holdings has also invited domestic and international companies with methane detection technologies to use the facility and has conducted evaluations of a range of methane measurement technologies. These include fixed methane monitoring systems, aircraft-based methane measurement methods using remote sensing technologies, and direct methane measurements using drones and infrared cameras. Through such testing and broad collaboration, JGC Holdings aims to advance methane emissions measurement technologies, which are still under development globally, and to contribute to the implementation of more effective methane emissions mitigation measures.

6. Challenges and Outlook

As discussed in this paper, methane emissions management across the LNG value chain has progressed through international frameworks, policy developments in major countries and regions, and corporate initiatives, leading to the increased availability of more transparent emissions data. However, several challenges remain in translating these efforts into more effective and sophisticated methane emissions management.

First, a key challenge is the lack of sufficient economic incentives to encourage corporate action. Given the costs associated with initial investment and the maintenance of monitoring systems, the economic rationale for companies to continuously introduce and operate methane mitigation technologies has not yet been fully established. LNG sellers and buyers operate in competitive markets, and under the current framework, methane emissions management is often perceived as an additional cost. It is therefore important not only for international frameworks and policies to provide overall direction, but also to establish mechanisms that generate tangible economic benefits for companies, such as greater market recognition and value for LNG with lower methane emissions.

Second, policy uncertainty and the effectiveness of regulation remain important challenges. In the United States, methane-related policies have been significantly rolled back since the Trump administration took office, creating uncertainty over the continuation of international methane mitigation efforts. As noted above, methane emissions management requires initial investment and ongoing expenditure to maintain monitoring systems. Policy uncertainty can therefore make corporate investment decisions more difficult.

Meanwhile, the EU requires stringent MRV requirements to be applied to imported fossil fuels. However, compliance with the EU Methane Regulation is not straightforward for US LNG because of the geographically dispersed nature of its supply structure. Against this backdrop, it has been suggested that the EU may consider flexible implementation or phased application of the methane regulation, given the important role of US LNG in reducing the EU's dependence on Russian gas. In this respect, while stricter regulation can promote greater data transparency, ensuring its effectiveness may be difficult unless implementation takes account of the practical realities faced by companies.

Despite these challenges, many companies and governments are working to improve methane emissions reporting methodologies, and increasingly transparent emissions data are being provided through international frameworks such as OGMP 2.0. Going

forward, it will be important to strike a balance between improving data transparency through international frameworks and policies and ensuring practical implementation that reflects the operational realities of companies. Progress in these areas is expected to support more effective methane emissions management and enable LNG with lower methane emissions — so-called “clean” LNG — to gain a competitive advantage in the market. In addition, as a major LNG importing country, Japan has an important role to play in using the CLEAN framework to support the development of MRV systems and the wider deployment of methane mitigation technologies for imported LNG through dialogue and collaboration with LNG producing countries.

7. Conclusion

This paper has reviewed developments in methane emissions management across the LNG value chain from the perspectives of international frameworks, policies in major countries and regions, and corporate initiatives. In recent years, methane emissions reduction and improved data transparency have become increasingly important factors in determining the environmental value of LNG, prompting governments and companies around the world to accelerate their efforts.

At the same time, technical and institutional challenges remain, including the development of accurate measurement and reporting systems and the establishment of policy frameworks that encourage corporate action. In particular, the divergence between the rollback of methane-related policies in the United States and the introduction of the EU Methane Regulation could affect the future direction of international methane emissions management. Against this backdrop, “clean” LNG with lower methane emissions and greater transparency is beginning to acquire a new competitive advantage in the market.

Going forward, the use of satellite monitoring technologies and further development of international MRV frameworks are

expected to contribute to the establishment of a more transparent data infrastructure. At the same time, deeper collaboration between LNG producing and consuming countries through initiatives such as CLEAN will be increasingly important.

References

- 1) Intergovernmental Panel on Climate Change (IPCC); Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the IPCC, (2021), p.1017.
- 2) International Energy Agency (IEA); Global Methane Tracker 2025, (2025), p.5.
- 3) Ibid., p.10.
- 4) Global Methane Pledge;
<https://www.globalmethanepledge.org> (Accessed on November 4, 2025)
- 5) United Nations Environment Programme (UNEP);
<https://www.unep.org/topics/energy/methane/about-imeo> (Accessed on November 4, 2025)
- 6) Oil & Gas Methane Partnership (OGMP) 2.0;
<https://www.ogmpartnership.org/partnership> (Accessed on November 4, 2025)
- 7) Japan Organization for Metals and Energy Security (JOGMEC); Coalition for LNG Emission Abatement toward Net-zero
- Sharing LNG project-level methane reduction measures -
https://www.jogmec.go.jp/english/news/release/release_00240.html (Accessed on July 20, 2023)
- 8) Cheniere Energy; 2024 Corporate Responsibility Report, (2024), p.17.
- 9) GHGSAT; IEA’s Flagship 2025 Global Methane Tracker Powered By GHGSat Data
<https://www.ghgsat.com/en/newsroom/ieas-flagship-2025-global-methane-tracker-powered-by-ghgsat-data/> (Accessed on May 7, 2025)

Contact: report@tky.ieej.or.jp