Recent Developments in Methane Emissions Management in the World and Japan

Seiya Matsukura*, Hiroshi Hashimoto**

1. Introduction

Companies involved in the natural gas and oil value-chains around the world are making efforts to reduce greenhouse gas (GHG) emissions in order to realize a decarbonized society. Until now, carbon dioxide (CO_2) has been the main GHG under international frameworks, but in recent years, methane (CH_4) has entered a new phase with the spread of similar initiatives. In the case of liquefied natural gas (LNG), of which Japan is the world's largest importer, methodologies for MRV (Measurement, Reporting and Verification) of methane emissions in the value chain of upstream development, transportation, and consumption have already been discussed worldwide. One of the reasons for the growing interest in methane emission management is the relatively high greenhouse effect of CH_4 compared to CO_2, which is 28 times greater over 100 years and 84 times greater over 20 years. In addition, compared to CH_4 emissions from agricultural and other sources, those from energy sources are considered to have greater room for effective control. Against this background, the United States is already pursuing policies to curb CH_4 emissions, and Europe is also moving forward with the standardization of MRV based on the EU Methane Strategy, which was announced in October 2020. In November 2021, more than 100 countries joined the Global Methane Pledge (GMP) initiative to reduce CH_4 emissions collectively by 30% from 2020 levels by 2030 at COP26 hosted by the United Kingdom, and the initiative's signatory base was expanded to more than 150 countries by the time of COP27 hosted by Egypt in November 2022. This paper introduces the current status and initiatives for CH_4 emissions management, which is rapidly expanding around the world, and summarizes measures and issues for Japan.

2. Global Methane Emissions

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

2.1. IPCC (Intergovernmental Panel on Climate Change)

The IPCC is an intergovernmental organization established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), 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 reports and thematic special reports. Regular IPCC reports have been produced every five to eight years, beginning with the First Assessment Report (FAR) in 1990, and the Sixth Assessment Report (AR6) synthesis report was released in March 2023. These IPCC reports are cited by policymakers around the world and serve as the basis for international negotiations, including the United Nations Framework Convention on Climate Change (UNFCCC), and for domestic policies.

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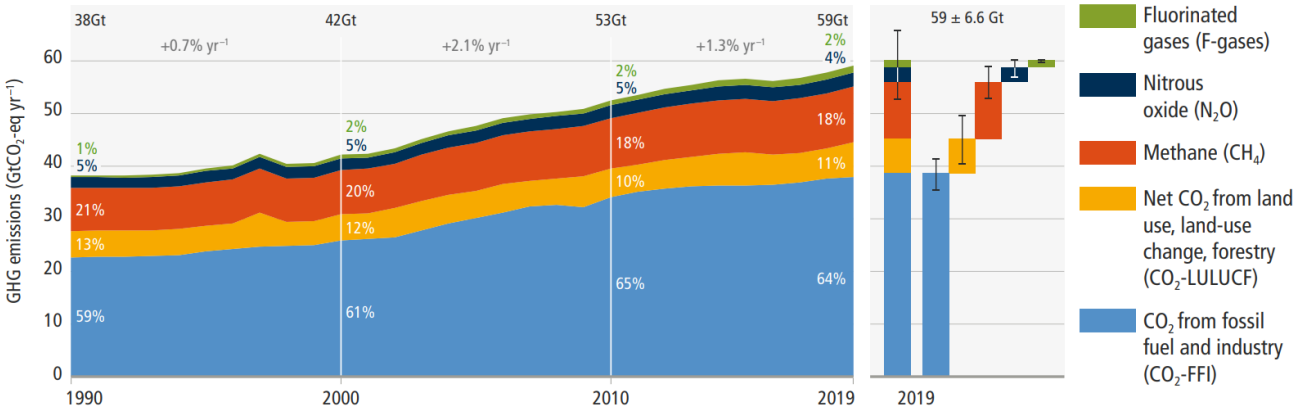
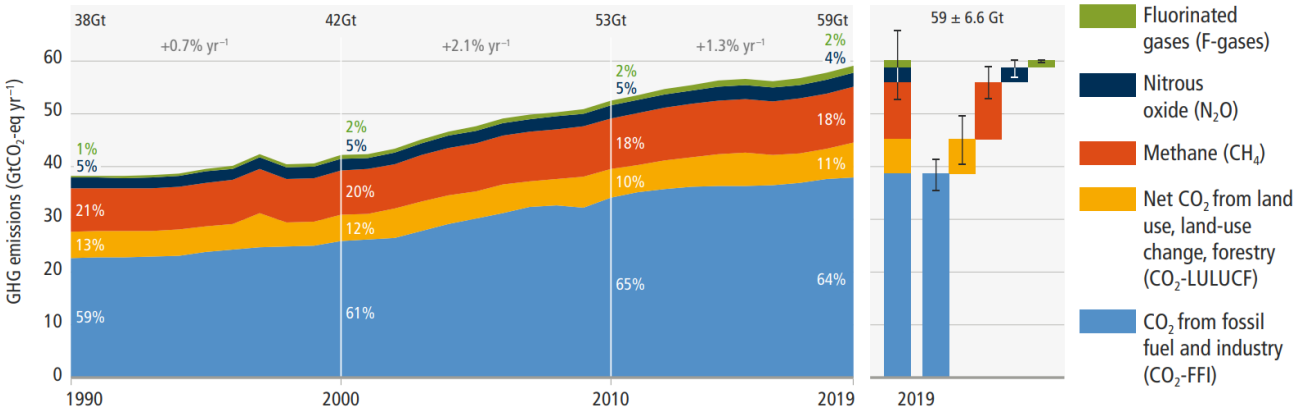


Figure 1: Global Net Anthropogenic GHG Emissions (1990-2019)

Source: IPCC Sixth Assessment Report (WG III) (2022)

The IPCC Sixth Assessment Report (WG I), published in August 2021, assessed that "there is no doubt that the increases in atmospheric CO_2, CH_4, and 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% CO_2 (64% of which is from fossil fuels), 18% CH_4, 4% N_2O , and the remainder 2% CFCs (fluorinated gases) and others. Among 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 during the last 6 years (2014-2019), with the dominant source being from human activities. In particular, since 2007, fossil fuels and agriculture (mostly from livestock) were considered the main contributors.



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2.2. IEA (International Energy Agency)

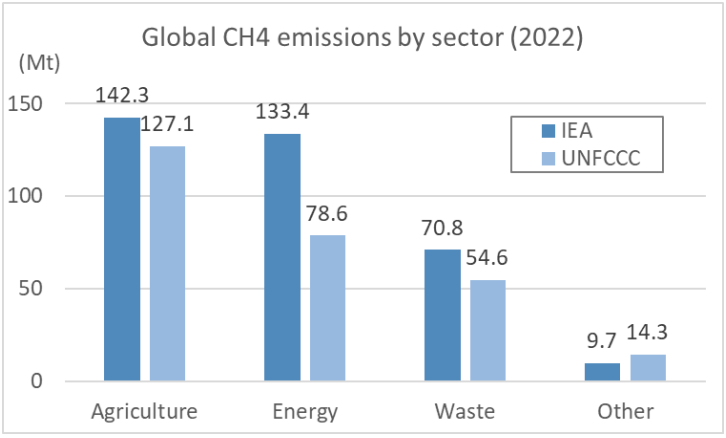

Figure 3: Differences in Global Methane Emissions data (IEA vs. UNFCCC) (2022)

Source: Compiled from IEA Methane Tracker 2023

According to the International Energy Agency's (IEA) Global Methane Tracker 2023, released in February 2023, the overall CH_4 emissions are larger than officially reported by governments such as the UNFCCC, suggesting that there is significant room for improvement in the respective aggregation methods. In particular, the tracker claims, methane emissions from the energy sector are 70% larger than officially reported values, and industry efforts such as reflecting actual measurement results in emission factors are expected in the future.

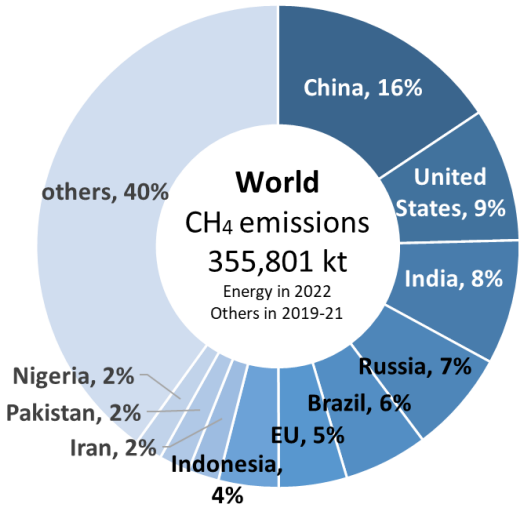

Figure 4: Global Methane Emissions (Share by Country) (2022)

Source: Compiled from IEA Methane Tracker 2023

According to the tracker, 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% share), followed by the United States with 31.84 million tonnes (9%), and India with 29.67 million tonnes (8%). The tracker estimates Japan's emissions in the year as 1.54 million tonnes (0.4% share).

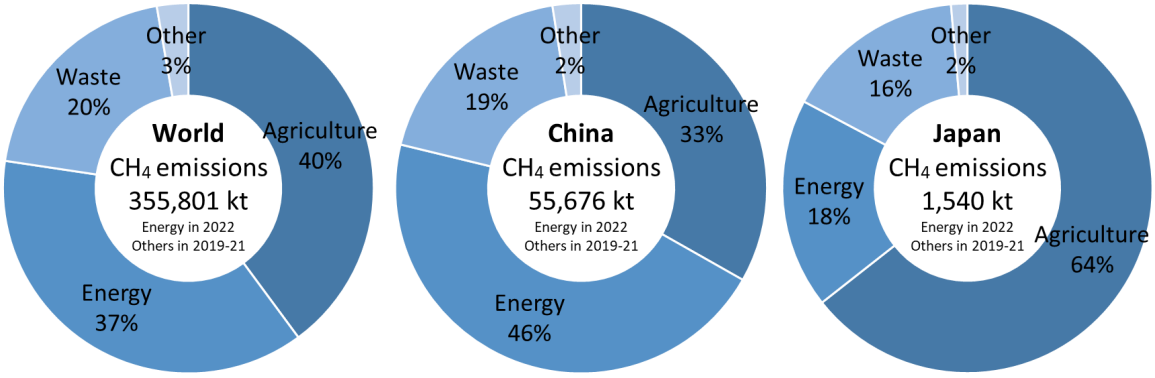

Figure 5: CH_4 emissions by Country (World, China, Japan) (2022)

Source: Compiled from IEA Methane Tracker 2023

According to the IEA, the largest source of CH_4 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, with 46% coming from energy in China and 64% from agriculture in Japan.

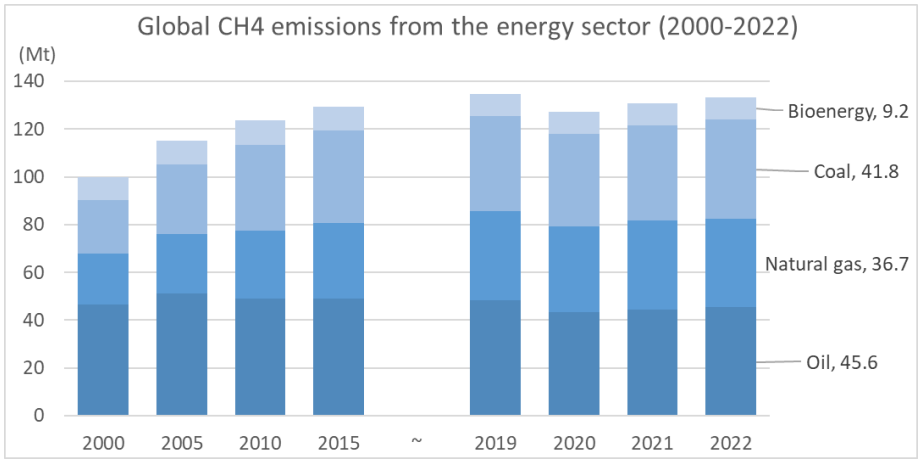

Figure 6: Global CH_4 emissions from the energy sector (2000-2022)

Source: Compiled from IEA Methane Tracker 2023

According to the IEA, methane emissions from the energy sector totaled 133.3 million tonnes in 2022, 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 countries' efforts to reduce emissions may have been partially successful.

3. Global Trends in Methane Emissions Management

This chapter describes policy trends in each country, with a focus on the United States and Europe, which are leading the way in methane emissions management. It also summarizes trends in the OGMP 2.0, a natural gas and oil industry-led leading methane emissions MRV framework, and its supervising body, IMEO, and the GMP, which aims to reduce overall global methane emissions.

3.1. Trends in the United States

During the period of the Obama Administration, the U.S. Environmental Protection Agency (EPA) announced the New Source Performance Standards (NSPS 2012) 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 NSPS 2016 regulation in August 2019 and removed methane from the transportation and storage portion of the gas in September 2020.

After Democratic President Biden took office in January 2021, the U.S. Senate adopted a proposal in April 2021 to reinstate methane emission regulations including the 2012 and 2016 "NSPS" for methane emissions from oil and gas operations set by the Obama administration. In January 2022, the United States also enacted "the U.S. Methane Emissions Reduction Action Plan", and in August 2022, "the Inflation Reduction Act (IRA)". The Act provides incentives for early implementation of methane reduction technologies and imposes emission charges on oil and gas facilities that emit in excess of certain standards. 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 in rapid succession.

3.2. Trends in Europe

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: (1) shifting gas consumption from natural gas to renewable and low-carbon gases, (2) reducing methane emissions in the energy sector, and (3) energy performance of buildings. In particular, (2) methane emission reduction regulations include: the 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 obligation of suppliers to submit information on their MRV and emission reduction methods with respect to imported fossil fuels.

Furthermore, in December 2022, the European Council (at the Heads of State or Government level) reached an agreement 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 would be required, and methane emissions from EU energy imports would also be tracked. The new rules also promote global monitoring tools to improve the transparency of methane emissions from oil, gas, and coal imports into the EU. The consideration of the bill now advances to the European Parliament.

3.3. OGMP（Oil and Gas Methane Partnership）

In November 2020, the OGMP announced OGMP 2.0, a new framework for MRV of methane emissions. 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. The latest OGMP2.0 framework was established by UNEP, the European Commission (EC), the Environmental Defense Fund (EDF), and the Climate And Clean Air Coalition (CCAC). The number of partner companies has increased from six at the beginning of the original OGMP in 2014 to 98 as of March 2023. Although no Japanese companies have not joined OGMP2.0 yet, their future participation in OGMP 2.0 could have significant impacts due to their presence in the LNG market.

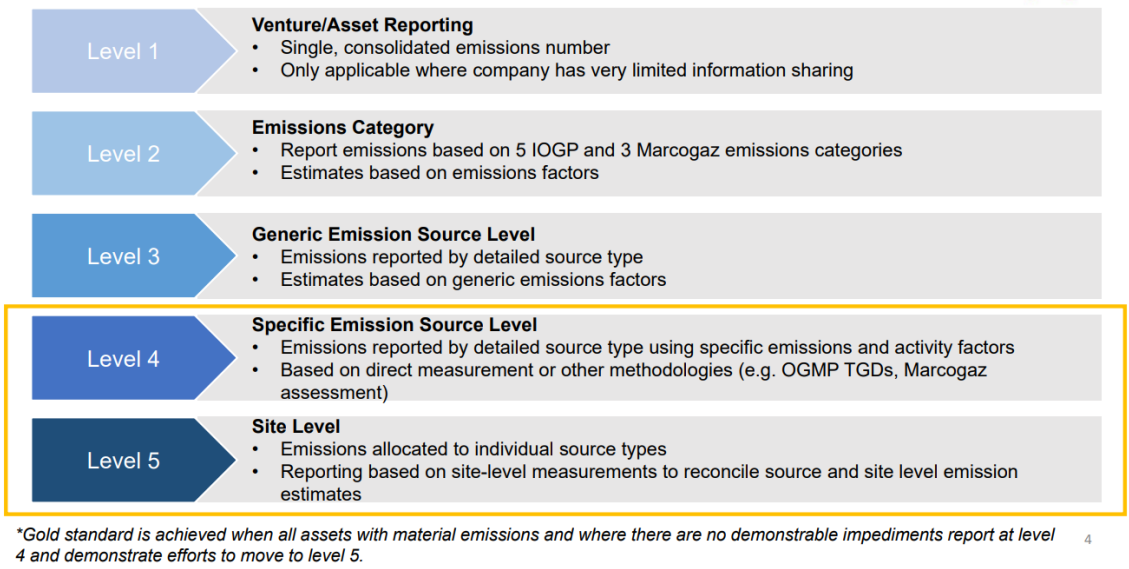

Figure 7: Five levels of CH_4 emissions measurement and reporting in OGMP 2.0

Source: UNEP

The OGMP 2.0 emissions measurement and reporting are 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," and 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 are required to commit to the initiatives as a condition of membership, not as an absolute requirement to achieve them by the deadline. Furthermore, reporting data will be published only by sector and source, and not on an individual asset basis. Only methane is covered, and other GHGs such as CO_2 are not. In addition, only Scope 1 emission sources are covered, Scope 2 and 3 are not covered, and a Global Warming Potential (GWP) of 72-85x is recommended for CO_2-based emissions calculations. The OGMP 2.0 Technical Guidance Documents (TGDs) have been published, which provide specific methodologies for Levels 3 and 4 for major emission sources. However, member companies may choose to adopt a different methodology, in which case proof of equivalence to the TGDs is required.

3.4. IMEO (International Methane Emissions Observatory)

In March 2021, the 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, 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 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.

3.5. OGCI (Oil and Gas Climate Initiative)

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 8: 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 USD 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 CO_2 reductions, and 9 CO_2 recycling projects) as of March 2023.

In addition, OGCI announced in July 2020 its commitment to join the Global Gas Flaring Reduction Partnership (GGFR) and the Payne Institute for Public Policy (PIPP) at the Colorado School of Mines in providing approximately USD 1 million in financial and technical assistance. The project develops an online platform, "Global Gas Flaring Explorer" featuring mapping and visualization of gas flaring data at oil production sites around the world. It is expected to improve monitoring and demonstration in the Zero Routine Flaring by 2030 (ZRF) 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 USD 4 million (USD 1.5 million for the United States, USD 1.5 million for Germany, and about USD 1 million for Norway) to support the GGFR.

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.

3.6. GMP (Global Methane Pledge)

In September 2021, the United States Whitehouse announced the Global Methane Pledge (GMP) at the Major Economies Forum on Energy and Climate (MEF) to reduce global methane emissions collectively by at least 30% below 2020 levels by 2030. In September of the same year, the second QUAD (Japan-US-Australia-India) summit meeting was held in the United States, 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 United States and the European Union (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. And in June 2022, the

United States, 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 are cost-effective and will 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 scientifically corroborate the methane emissions reported by companies 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 U.S. government, the Global Methane Hub, and the Bezos Earth Fund.

4. Methane emission reduction measures and associated MRV framework

This chapter summarizes the main MRV methodologies and measurement techniques related to methane emissions, as well as emissions accounting schemes and framework development efforts undertaken by operators in the LNG supply chain. One example of the background to these efforts is carbon neutral (CN) LNG, which was introduced around 2019-2021, but the detailed rules for offsets and other details have not yet been determined, leading to criticism of "greenwashing".

4.1. Major Guidelines for GHG Emission Calculation/Reporting Standards

(1) EPA (U.S. Environmental Protection Agency):

The EPA was established in 1970 and the EPA Mandatory Greenhouse Gas Reporting Rule (GHGRP) was published in 2010. The purpose of the GHGRP is to provide accurate and timely GHG data to stakeholders. It covers facilities that directly emit 25,000 tons of CO_2 equivalent or more per year. Suppliers of specified products that lead to GHG emissions through emissions, combustion, etc. are required to submit an annual report to the EPA.

(2) API (American Petroleum Institute):

The API, the standard-setting organization 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 characterization of GHG emissions in the oil and gas industry: i) API Compendium, ii) Guidelines, iii) API Template, iv) Sustainability Guidance, and v) Uncertainty Document.

(3) AGA (American Gas Association):

The AGA was established in 1918 as the U.S. gas supply industry association. The AGA publishes standards and guidelines related to the Natural Gas Sustainability Initiative (NGSI) to support ESG initiatives of companies in the gas value chain.

(4) Marcogaz:

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.

(5) MiQ:

The MiQ was established in December 2020 by the U.S. RMI and the U.K. SYSTEMIQ as a third-party auditing organization for methane. It has developed its own 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 the use of a new rating system for facilities that are scheduled to be completed by 2023. As a recent development, in January 2023, MiQ announced that it had monitored and rated 17% of U.S. gas production in one year, and that 10 companies, including bp, Exxon, and Chesapeake, had obtained certification.

(6) GIIGNL (International Group of LNG importers):

The GIIGNL was established in 1971 as an industry association for LNG importers. In November 2021, the GIIGNL MRV and GHG Neutral LNG Framework, incorporates all GHG emissions associated with cargo. 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 2023 that it had delivered LNG from Gorgon LNG (Australia) to CPC (Taiwan) for the first time in accordance with the framework.

4.2. Main measurement technologies: Satellites, Drones, OGI (Optical Gas Imaging) cameras

This section summarizes the characteristics and main approaches for satellites, drones, and OGI cameras, which are commonly used in measurement technology surveys.

4.2.1. Satellites (Top Down)

Although wide-area observations of methane emissions by satellite have proven to be 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 of time. 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 GHGSat, a company specializing in monitoring satellite technology, Scepter, a general measurement company, and 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 in order to make global data on methane emission sources available.

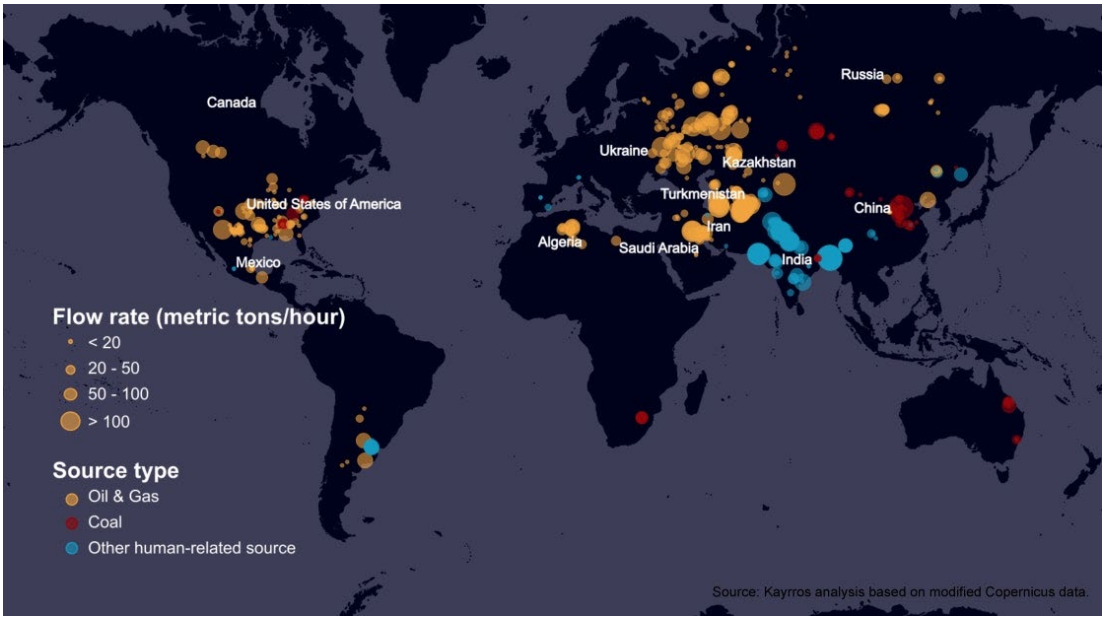

Figure 9: Methane emissions from human activities detected by satellite (2022)

Source: Kayrros

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 more than 1,200 methane emission events of 25 tonnes per hour or more detected by satellite in 2019 - 2020 were observed as ultra-emitters, but these were not included in national GHG inventories. It also noted that the majority of these were in the six largest oil and gas producing countries (Turkmenistan, Russia, the United States, Iran, Kazakhstan, and Algeria).

4.2.2. Drone (Top Down / Bottom up)

Drones are considered promising as a method that is less expensive than satellites and 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, non-explosion-proof, and the absence of regulations under domestic laws and regulations. SeekOps is one of the leading measurement companies.

4.2.3. OGI (Optical Gas Imaging) camera: (Bottom up)

OGI cameras are considered a more quantitative method of observation 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.

4.3. Major Upstream Operator Initiatives (Production Sector)

4.3.1. QatarEnergy, PavillionEnergy, Chevron; SGE Methodology

In April 2020, Singapore's Pavilion Energy solicited LNG deliveries of up to 2 million tonnes per year for five 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 is complementary to GIIGNL's MRV and GHG Neutral Framework efforts.

4.3.2. Cheniere Energy, CE Tags

Cheniere Energy of the United States announced the release of an LNG Life Cycle Assessment (LCA) analysis that will improve the way it assesses GHG emissions in August 2021. The analysis utilizes 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 will collaborate with natural gas midstream companies, methane detection technology providers, and university research departments, including Colorado State University, to Quantify, Monitor, Report and Verify (QMRV) GHG Emissions in its LNG supply chain. The QMRV implementation will use a combination of 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.

4.3.3. Five International Major Companies

(1) ExxonMobil:

In September 2021, the company 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 per 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.

(2) Chevron:

In May 2022, the company announced that it is working to improve its own methane emissions detection and reduction through multiple approaches, including surface and overhead. Also in February 2023, Chevron New Ventures and Egypt's Ministry of Petroleum and Mineral Resources (MOPMR) announced that they had signed a Memorandum of Understanding (MOU) to share best practices and expertise in methane emissions reduction.

(3) TotalEnergies:

In May 2022, the company announced that it will begin drone-mounted emissions detection and surveying at its upstream oil and gas operations. This will be done using AUSEA (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. The company expects to reduce methane emissions by 50% by 2025 and 80% by 2030, compared to 2020 levels.

(4) bp:

In March 2022, bp ventures announced a EUR 3 million investment in Flyogix, a pioneer in the unmanned aerial vehicle (UAV) business that uses drones to help monitor and measure methane gas. In addition, in March 2023, bp's U.S. 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.

(5) Shell:

In 2020, the company announced that it would use drones to enhance methane leak detection and repair (LDAR) at its more than 400 sites in the Permian Basin in the United States. The company is targeting a methane emission intensity of 0.2% or less by 2025 for all oil and gas assets it operates.

4.4. Midstream Operator Initiatives (Transportation Sector)

Methane emissions occur in the LNG value chain, for example, and some events involve leaks during LNG transfer to liquefaction facilities or LNG carriers. Boiloff gas (BOG), which is partially evaporated from the heat input to the tanks, may also be discharged during loading and may occur as unburned gas (methane slip) in marine engines.

According to the IEA, based on detailed data on global LNG trade and data measured by the GHGSat satellite, total methane emissions from LNG liquefaction plants and shipping in 2022 are estimated to be about 0.4 million tonnes, or about 0.1% of the annual globally transported LNG volume of 400 million tonnes.

The International Maritime Organization (IMO), one of the specialized agencies of the United Nations (UN), is studying LCA guidelines for GHG emissions from marine fuels. Currently, the draft guideline for the assessment of GHG emissions throughout the life cycle of marine fuels (LCA guideline) jointly prepared by Japan, Australia, Norway, and the EC is being considered as a base document, and is scheduled to be finalized at the 80th MEPC (Marine Environment Protection Committee) in July 2023.

In addition, in September 2022, the Safetytech Accelerator, established by Lloyd's Register, announced the launch of the Methane Abatement in Maritime Innovation Initiative (MAMII), an initiative to reduce methane emissions from shipping. MAMII is an initiative to reduce methane emissions from shipping. Initially, seven companies, including Maran Gas Maritime, Shell, and others, will support the initiative. The MAMII also states that in its first six months, it has mapped the status of LNG fuel from well to ship and identified key measurements and potential new technologies for onboard measurement. In addition, in March 2023, seven international LNG shipowners and operators, including CoolCo, Mitsui O.S.K. Lines (MOL), and TMS Cardiff Gas, announced that they had joined MAMII.

5. Trends in Japan

This chapter describes policy trends in each country, with a focus on the United States and Europe, which are leading the way in methane emissions management. It also summarizes trends in the OGMP 2.0, a natural gas and oil industry-led leading methane emissions MRV framework, and its supervising body, IMEO, and the GMP, which aims to reduce overall global methane emissions.

5.1. Greenhouse Gases and Methane Emissions in Japan

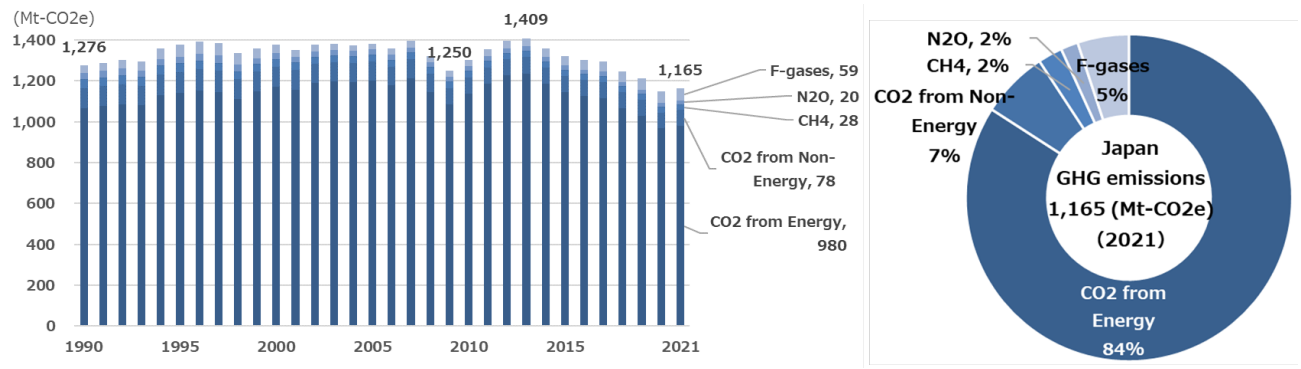

Figure 10: Japan's GHG emissions (FY1990-2021) *FY2021 figures are provisional.

Source: Compiled from NIES' information, based on data from the Greenhouse Gas Inventory Office

According to provisional data from the NIES as of February 2023, Japan's total GHG emissions in FY2021 were 1.165 billion tonnes (CO_2 equivalent), a 17% decrease from the record 1.409 billion tonnes in FY2013. Methane emissions account for 2.4% of the total GHG emissions, at 28.33 million tonnes (CO_2e) in FY2021 (provisional data, based on methane's GWP 25).

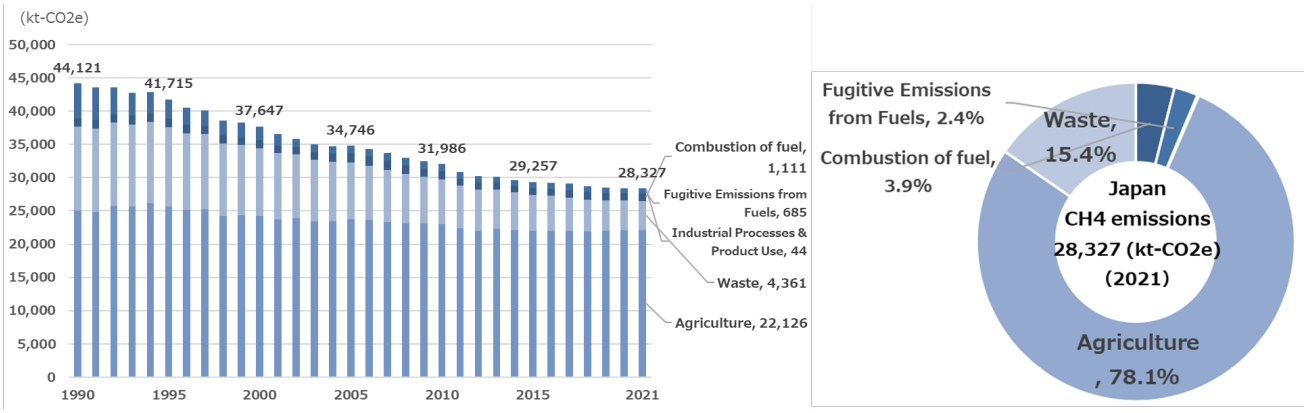

Figure 11: Methane Emissions in Japan (FY1990-FY2021) *FY2021 figures are provisional.

Source: Compiled from NIES' information, based on data from the Greenhouse Gas Inventory Office

Methane emissions (CO_2 equivalent) in Japan have decreased by 15.79 million tonnes (36%) over the approximately 30 years from 1990 to 2021. Looking at the breakdown of 28.33 million tonnes of methane emissions (CO_2e) in FY2021 (provisional figures), agriculture-derived emissions accounted for the largest share of 78.1% at 22.13 million tonnes, followed by waste at 4.36 million tonnes or 15.4%, Energy-related activities accounted for 1.8 million tonnes, or 6.3% of the total. Here, if the GWP of methane is converted to 25, CH_4 emissions in 2021 would be 1.13 million tonnes, 36% smaller than the 1.54 million tonnes of CH_4 emissions in Japan estimated by the IEA.

5.2. JOGMEC: GHG and CI Guidelines

In May 2022, JOGMEC (Japan Organization for Metals and Energy Security) developed and published the Recommended Working Guidelines for Calculating GHG Emissions and Carbon Intensity (CI) of LNG, Hydrogen, and Ammonia (GHG and CI Guidelines). The guideline is an approach to the calculation of GHG emissions associated with the production of different energy products and the calculation of CI, which indicates GHG emissions per unit. The guideline has been developed by JGC Global engaged through the JOGMEC project.

In September 2022, JGC HD announced 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 (MC) as a shareholder, to conduct GHG emission measurement, including methane. Prior to this, in March 2021, JOGMEC and MC agreed with PAU to conduct a joint study on CCS and carbon dioxide utilization 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 ton of ammonia at PAU's production site from November to December 2022. This was the first measurement case in which the guidelines were applied as part of a JOGMEC project. It is expected that Japan will continue to expand its technical contribution by applying the same method to other facilities in Asian countries.

5.3. Trends in the Ministry of Environment (MOE), Japan

(1) Satellite Project GOSAT Series

A The NIES, MOE, and the Japan Aerospace Exploration Agency (JAXA) are promoting the GOSAT series of satellite projects to observe GHGs from space. SATellite (Ibuki), the world's first technical satellite dedicated to GHG observation, was launched in January 2009, and started continuous observation of CO_2 and CH_4 concentrations. In 2018, the GOSAT-2 (Ibuki 2), was also launched and began observations of carbon monoxide (CO) in addition to CO_2 and CH_4. The third satellite, GOSAT-GW (Global Observing SATellite for GHG and Water Cycle), is currently under development for launch in FY2024. As a major achievement in recent years, in March 2022, GOSAT observation data revealed that the average annual increase in the total atmospheric concentration of methane from 2011 to 2020 was 8 ppb, while the annual increase in 2021 was 17 ppb, the largest since the start of observations. In November 2022, they also analyzed methane emissions in China (2010-2018) and found that methane emissions varied significantly by region. In particular, they found significant increases in China as a whole and in northeastern China.

(2) 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 own emissions and report them to the government, and the government publishes the reported information. Since the introduction of 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, and there was a situation in which there was a discrepancy between the activities covered by the national inventory and those covered by the SHK system. In January 2022, the MOE and the Ministry of Economy, Trade and Industry (METI) established the "Study Group on Calculation Methods in the SHK System," held a total of five discussion sessions on the review of calculation methods, and released an interim summary in December 2022. In the summary, based on the scheduled review of the GWP used in the national inventory, it was 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 (= emissions in 2023) for methane.

5.4. LNG operators: Reporting of emissions

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

Table 1: Methane Emissions Disclosure by Japanese Companies (2017-2021)

(Tonnes)			CH4-t					CO2e-t				
Industry	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

※ Blue Text: Converted value = 25 (CO2e-t/CH4-t), GWP 100

Source: Compiled from company data * Blanks indicate undated data

In recent years, an increasing number of 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 greenhouse gases 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".

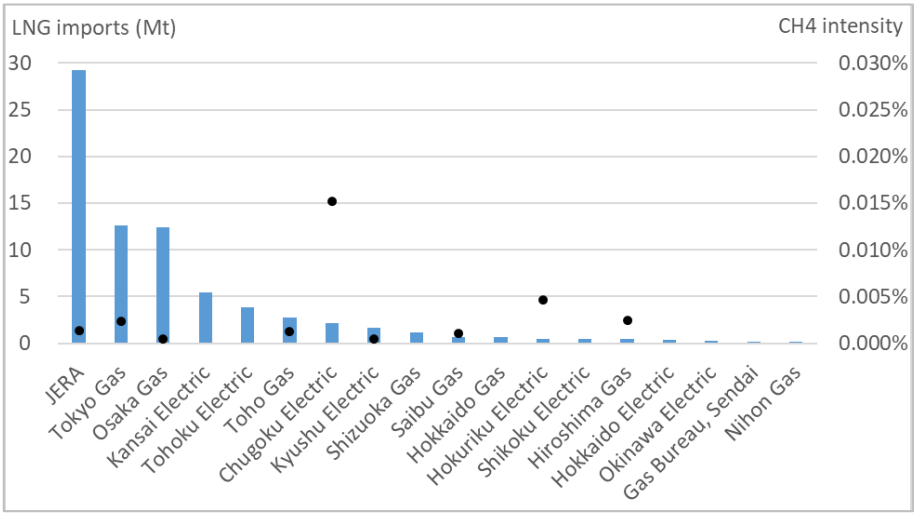

Figure 12: LNG imports and methane emission intensity by Japanese companies (FY2021)

Source: Compiled from data included in each company's sustainability report

In recent years, there has been active public disclosure regarding methane emissions. Calculating the methane emission intensity (methane emissions / LNG imports) of Japanese companies, the values are mostly controlled at low levels, less than 0.005%. 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, which has been awarded Level 4 for two consecutive years among OGMP 2.0 participants, has relatively large methane emissions of 2,140 tonnes in 2021 and an emission intensity target of 0.022% by 2025.

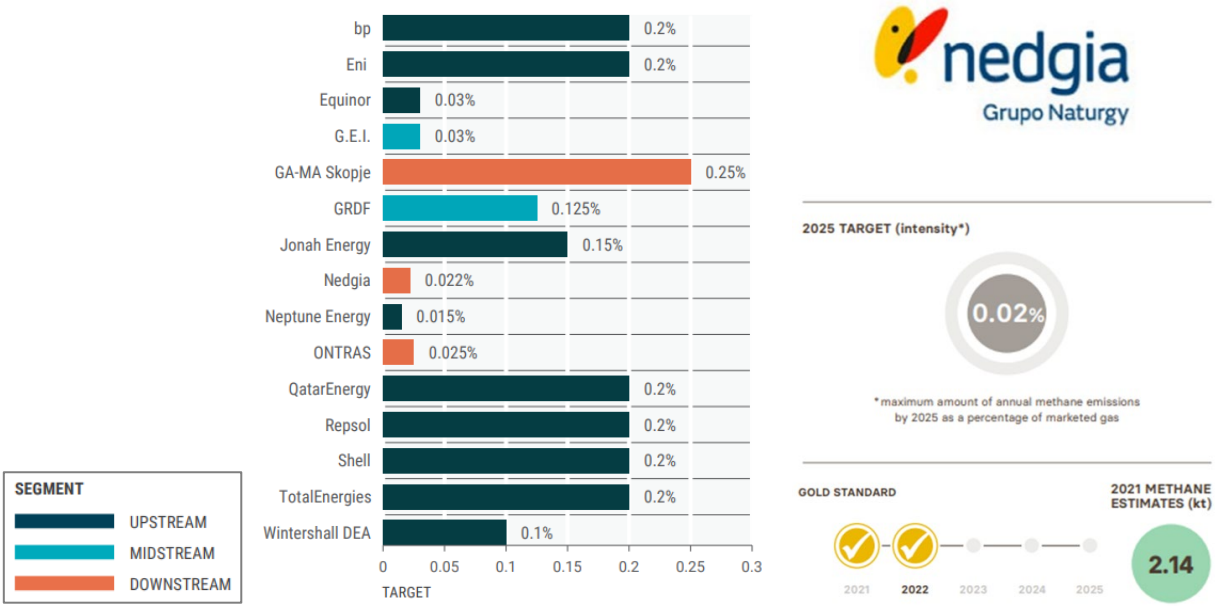

Figure 13: Methane Emission Intensity Targets for OGMP 2.0 Member Companies (2021)

Source: IMEO 2021/2022 Report

5.5. Potential Contribution of Japanese Companies

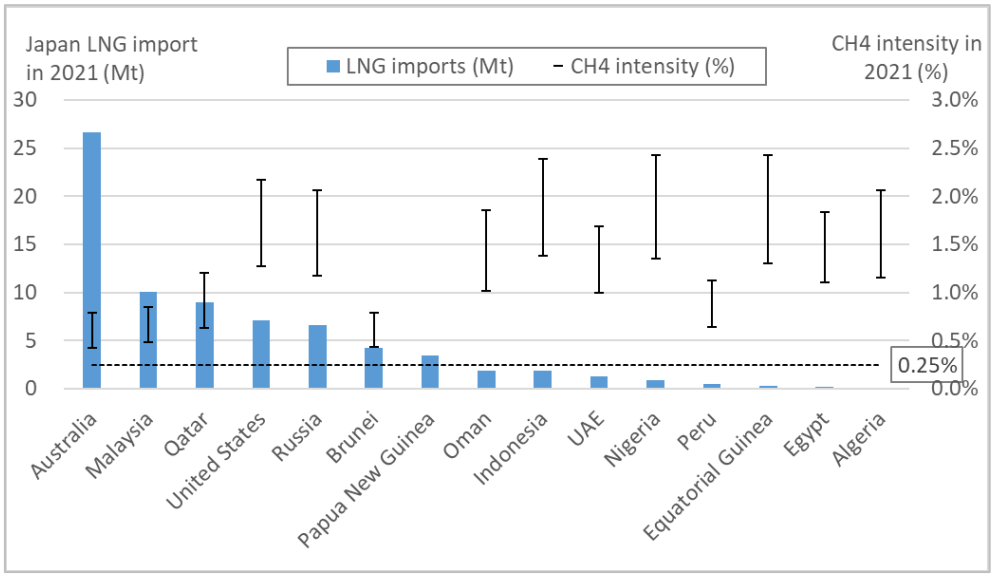

Figure 14: Japan LNG Imports and Methane Emission Intensity by Country (2021)

＊CH_4 intensity: (Min) (Emissions from On/Offshore gas production) divided by total gas production,
(Max) (Emissions from [Gas production + PL/LNG facilities]) divided by total gas production

Sources: Trade Statistics of Japan, IEA Methane Tracker 2022, IEA Natural Gas Information 2022

The methane emission intensity for each country from which Japan procures LNG (except Papua New Guinea, which has no emission data) exceeds 0.25%, although it includes not only the intensity for the LNG production value chain but also the intensity of the overall gas production and other activities. Japan has a large number of companies with advanced engineering technologies, and there is potential for Japan to contribute to the world by utilizing its methane leakage prevention technologies.

In recent years, Japanese companies have also been working to reduce methane emissions in other countries. For example, in April 2022, PERTAMINA, Osaka Gas, INPEX, and JGC HD signed an agreement for joint research on the utilization of 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 utilize this methane as biomethane. In March 2023, JGC HD 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. Conclusion

This paper provides a cross-section of global methane emissions management trends, from policies mainly in Europe and the United States, and from international frameworks to corporate initiatives. Among them, attention to methane emissions management is rapidly increasing, as represented by the Global Methane Pledge (GMP), a common global goal launched in 2021. Japan, as the world's largest LNG importer and having been involved in the LNG value chain for more than 50 years, has a responsibility to pursue cleaner natural gas. As an LNG buyer, Japan will increasingly need to cooperate with LNG sellers in order to continue using natural gas in the future. In this context, Japan, as a leader in Asia, is expected to contribute to the management of methane emissions through the advanced technological capabilities it has cultivated to date and its ability to collaborate with other countries.

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